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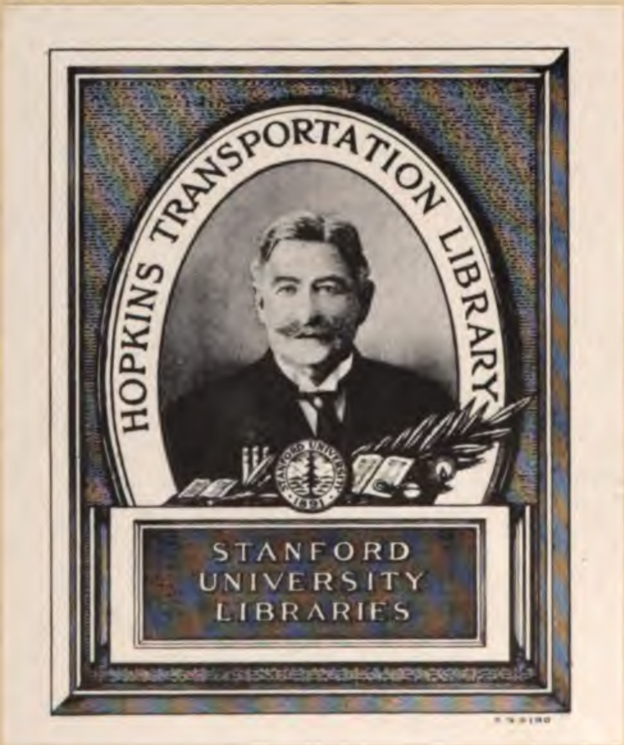

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# Flying.

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PROFESSOR LANGLEY.

# Flying.

## THE JOURNAL OF AERONAUTICS.

WITH WHICH IS INCORPORATED

THE FLYER, THE FLYING MACHINE, THE AERONAUT.

No. 1. QUARTERLY. DECEMBER, 1901.

# INTRODUCTORY.

IN deciding to issue a magazine dealing with aerial navigation, we have been influenced by the widespread desire which exists for information on this ever-fascinating subject. We make no attempt at prophecy, but there is no question that flying by human beings is nearer realisation than many people imagine, and, when we reflect upon what has been done in other branches of engineering, it requires a very small effort of the imagination to realise what may transpire in the development of aerial navigation in the near future. It is not our intention here to refer to history or to deal with past attempts, but there is no question that the comparatively recent work of Professor Langley, Mr. Hiram Maxim, Count Zeppelin, M. Santos-Dumont, and others, has directed attention to the subject and aroused an interest of much greater intensity than has ever before been evinced in the matter.

This growth of interest is due to a variety of causes, and we are of opinion that the longing for aeriel flight has been greatly brought about by the sports of cycling and automobilism. Five or six years ago very few indeed had tasted the delightful abandon of a rush at full speed through the air, but the free-wheel bicycle has enabled thousands to enjoy this experience, or something approximating it, but the rush of the descent is soon over, and the rider sighs for a repetition of the exhilarating motion. Then, in the automobile, particularly in the high-powered machines, the foretaste of the sensation of flying is still nearer the reality, though the considerations of traffic and road surfaces, not to mention police espionage, remind the automobilist that he is still tied to earth. Yet the fact remains that these delightful methods of terrestrial locomotion have shown the modern man what can be done, and he longs for the full freedom of aerial travel. Consequently, hundreds are interested in the subject of flying to-day where a few years ago the matter was one only considered by a few scientists and enthusiasts, for it must be confessed that the attitude of the average individual with regard to these men was that of charitable toleration for the hobbies of persons who were considered to be little better than amiable lunatics. Quite apart from any advances which have been made in the art of recent years, it is necessary to bear in mind the fact that the modern investigator has at his hand the material and workmanship which the pioneers never enjoyed, and it is now possible for him to obtain motors of extraordinary power in regard to their weight, and not only so, but the tubing for the framework of his aerostat, and, in fact, almost every part, can be obtained with a strength in regard to lightness which was impossible only a few years ago. Here again we see the influence of the cycle, for the demand for lightness on the part of users of the pedal-propelled machine has resulted in those engaged in that branch of light engineering devoting every effort to the reduction of weight without sacrifice of strength, and, in consequence, brands of weldless steel tube of wonderful lightness, considering their strength, are now in everyday use. This also applies to the chains, the bearings, and, in fact, we may say to every part of the cycle. Then, again, we have to consider the motive power. Quite recently it was necessary, if a light and very powerful engine was required, for the would-be aeronaut to make every part of his engine from original designs out of special material and at a fabulous cost. Now a motor of 70 h.p. on the brake is made in this country which only weighs 10 lbs. per h.p., and even this can be reduced in weight without great cost if necessary. Therefore it will be seen that, apart from any development in the flying machine itself, the materials and requisites are practically ready to the hand of the experimenter, and these facts alone warrant the indulgence of great hopes for the possibilities of the near future.

To return to the mission of this magazine, we may say it is our intention to make it of an extremely elementary character, as well as to provide matter of interest to the expert aeronaut. Most of those who have a knowledge of the subject have devoted years to its acquirement, and comparatively little written lore is available for the newcomer into the world of aerial navigation. Therefore, it is our intention to deal very largely with first principles, and while keeping touch with the present to devote very special attention to the past, where it will afford information as to the principles guiding those engaged on the problem of aerial flight to-day, and by these means we hope to foster the growing interest in the subject, and to provide our readers with information which will enable them to understand it in all its bearings and to realise its difficulties and its possibilities. Finally, it should be clearly understood that the magazine is published independently, and without any connection with, or bias in favour of, any particular association, society, or club. It will record the doings of the world of aeronautics with absolute impartiality.

## Military Kites.

Seven or eight years ago Major Baden-Powell, a distinguished member of the Aeronautical Society, after much experimenting, evolved a flat kite without a tail which could be folded up for transportation, and yet, when several of them were coupled together, sufficed to lift a man. He thus demonstrated that for army purposes kites might often advantageously supplant balloons.

## M. Santos-Dumont's Belief.

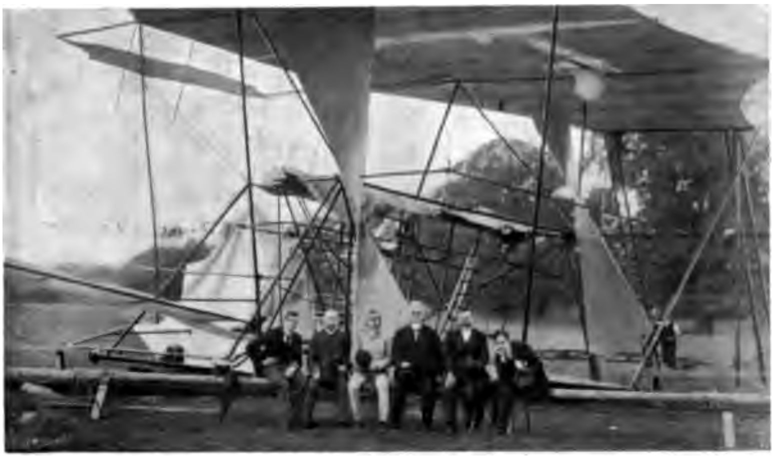
M. Santos-Dumont, when speaking the other day in Paris, referred to the Army Balloon Factory at Aldershot, which he said was in full activity. He regarded the vast camp at Aldershot as a splendid field for the rapid perfecting of the steerable balloon, and believed that Colonel Templer and the engineer corps at Aldershot were doing their utmost to solve the problems which attended the application of "the science of the air" to military requirements.

# Professor Langley.

PROFESSOR S. P. LANGLEY, the long-distinguished secretary of the Smithsonian Institution, Washington, U.S.A., and eminent physicist and aeronautical specialist, whose portrait appears as our frontispiece, may justly claim to have attained to greater distinction in the promotion of true mechanical flight, both in literary work and in untiring experiment, and to have achieved more truly valuable practical results in that field than any preceding him.

For no less than sixteen years has Professor Langley steadily devoted himself to this fascinating study, and happily with such an intelligent grasp of the subject that eventually—after oft-repeated and long-protracted disappointment and failure, to survive which undaunted argues no ordinary man—he scored a veritable triumph in the production of a mechanical "flying machine" that really does fly, and flies with remarkable stability and grace for protracted flights by steam power alone. This admirable machine, be it said, is of such dimensions as to be more than a mere model, and, indeed, to approximate closely to the condition of one carrying a passenger, but at a disadvantage compared with the latter in the absence of intelligent control on board, and a consequent intentional limiting of its range to flights of about threequarters of a mile.

Prof. Langley is happily still working assiduously towards the production of a passenger-bearing "Aerodrome," and at any time we may hear of its successful trial.



**THE MAXIM AEROPLANE,**
**With group of visitors.**
**(Taken on the day of final semi-successful trial, Baldwyn's Park, 1st August, 1894.)**

# Motor-Aviation of To-day and of Recent Years.

## By SIDNEY H. HOLLANDS.

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### INTRODUCTION.

WITH regard to matters aeronautical there has been from time to time much false and groundless exultation, much simple wonderment among the people, for which untimely outbursts the daily press is largely responsible. In fact the press has tended not a little to cover the whole subject with undeserved ridicule "as with a garment," as each extravagantly reported and extolled event or "achievement" has ended in a fiasco or worse.

In the majority of cases—either balloon schemes or parachutic attempted feats of launching or dropping the machine from a perilous height—the absurd, if not tragic, end could have been foreseen by a practical engineer (or even by anyone possessing only an elementary knowledge of physics), who would therefore prudently refrain from any sanguine predictions.

Any display of sanguineness, exaggeration, or prediction is to be strongly deprecated, yet these have hitherto been the leading characteristics of the average newspaper press report when dealing with this subject. Unfortunately, too, the fascinating hobby of aeronautics has attracted a large number of persons whose knowledge of physical laws is quite inadequate to a proper grasp of the subject, and who consequently get widely adrift in the field of experiment, stultifying themselves, and provoking derision.

The writer is convinced that to approach this greatest of mechanical problems mathematically is of no practical use. Mathematicians have tried hard, but their labours have, unfortunately, produced no real practical results. One of them—the Italian Borelli—certainly did "prove" that a goose must exert *300 horse-power* in order to fly, but it must be said for him that he thereby distinguished himself above the average. That achievement of his will probably live and remain "green" wherever and whenever flight is discussed.

The writer also desires in his articles to rigidly exclude the sensational factor and all appeals to the sense of wonder. Those fabulous aerial crafts created in fiction by Jules Verne (in his "Clipper of the Clouds") and by Mr. H. G. Wells, though nice and romantic, are, it is almost needless to say, entirely impracticable as described and illustrated. It is rather to be feared that the portrayal of such chimerical craft has a tendency to (at least) engender a doubt in the popular mind as to the possibility of purely mechanical flight at all.

On the other hand, fortunately, there is the conviction held by such well-known authorities as Brearey (deceased), Professor Langley, Hargrave, Maxim, Professor Hele-Shaw, Lord Rayleigh, Chanute, Lamson, Lilienthal (deceased), Major Baden-Powell, and finally, but by no means least, the learned and lately deceased Duke of Argyll, founder and past president of the British Aeronautical Society.

This abundant and influential advocacy, together with the admirable and most useful work of these gentlemen for the promotion of the science, should quite suffice to counteract the above-named tendency and discredit the advocates of levity.

An expressive aviationist has said: "Wings may well be considered (in man) the missing link of perfect duality."

Another writer produced the following encouraging couplet, somewhat in the same strain:

> "Sink not in spirit, who aimeth at the sky
> Shoots higher much than he who means a tree"

The estimable Dr. Erasmus Darwin, as long ago as the year 1781, wrote the following far-seeing prophetic lines:

> "Then shall thy arm unconquered steam afar,
> Drag the slow barge, or drive the rapid car,
> Or on slow waving wings expanded bear
> The flying chariot through the fields of air."

An American writer once (in 1895) well and humorously remarked: "Formerly nearly all inventors of flying machines were supposed to be more or less weak in the upper storey, and if it became known that any man—however intelligent or scientific—was at work upon a flying machine his reputation for sanity was endangered almost beyond hope of salvation. To-day we have the ablest engineers, mechanicians, and physicists studying the problem with all the ability which modern training can give, and lo! public opinion promptly trims to meet the new conditions, and awaits results with rather impatient expectation."

It is the author's desire to deal impartially with both the facts and the fallacies of this question.

No right-thinking person would class that which is wholly consistent with physical laws with such a really visionary and obviously false theory as "perpetual motion" and its kindred old-world fallacies.

To revert, however, to the practicable. Aeroplanes will probably become as much a dead letter in the near future as "valvular" wings are now, and "aerocurves" will quite supersede them, as the latter unquestionably give far better results, perhaps by reason of the appliance being nearer to nature. In fact, "aeroplanes" may already be almost regarded as things of the past. (See figs. 1 and 2.)

Referring to the valvular-wing theory, the writer must confess that as a boy he wasted much time which might have been better employed in constructing a valvular-action model, the little reciprocating steam motor of which worked all right, but, of course, the machine would not lift "worth a cent." However, he did at least satisfy himself that the system was altogether impracticable.

It has been well remarked that "there is nothing occult nor inimitable in birds' flight, as it is purely a mechanical operation, and depends on the exertion of adequate power applied to the air through the medium of the wings." The writer, however, would prefer to qualify this statement thus: "There is nothing occult nor inimitable in the simple flapping* flight of birds," etc., and would add, too, that it does not in the slightest degree depend upon buoyancy or levity.

Moreover, we know that there is no analogy in nature to the balloon, as no living creature flies by buoyancy. It is a curious and noteworthy fact that there is an ineradicable idea with most people that an air craft must be of the nature of a balloon, and they have no notion, seemingly, of any other means of sustentation, whereas that is just what it must not be. It is quite monotonous to hear and read so frequently about "The development of the balloon," "An invention for steering balloons" (as if steering were the primary difficulty), etc.

The late Mr. F. W. Brearey—then hon. sec. of the British Aeronautical Society—once rightly remarked: "Total misapprehension of the principles of flight is displayed whenever the balloonist is recommended to take off part of the weight of any mechanical arrangement."

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* This imitated artificially is distinguished as "orthogonal" flight.

In these articles, then, the writer will *not* deal with any schemes of flight by levitation, nor by man's unaided muscular power, except to show their impracticability. Both of these systems he holds—in common with numerous other devotees to true flight—to be now exploded and finally rejected by all orthodox thinkers, or indeed by all possessed of common sense, which, by the way, we know is remarkably uncommon.

Referring to the numerous schemes of flight dependent on man's unaided muscular power, an American aviationist* wrote: "If man were a butterfly, bug, beetle, or small bird, weighing a few ounces, he would have a good time of it, but his 100 lbs. (and more) avoirdupois effectually bars the way to any possibility of *active* flight derived solely from his physical exertions."

Another writer says: "Let us consider the common flea—too painfully common—which will jump at one bound *two hundred times its own length.* Now, if a man possessed the same proportionate power he would, standing on Ludgate Hill, be able to jump clean over the dome of St. Paul's Cathedral without putting forth his full strength. Could he accomplish such a leap we might feel satisfied that the power could be utilised for putting in motion a pair of wings for his support in the air; but man is, compared with the lower creation, a weakly thing for his size."

The succeeding articles, then, will treat of true mechanical flight, or, to express it in one word, "aviation," the ability possessed by birds, bats, and bluebottles, not forgetting the flying fish.

## THE QUESTION OF UTILITY.

The true flying machine, the aviator, or bird-like air-craft, bears about the same relation to the balloon—in the matter of controllable locomotion—as the submarine boat bears to the old diving-bell, although it may be added that in thus associating the balloon and the diving-bell the latter has been of far greater utility and less destructive to human life. One is occasionally asked, "Of what practical use will the power of air-sustained locomotion be to mankind when attained?" It must be admitted that this is a very pertinent query, and one which previous writers on this subject have mostly missed, or, it is to be feared, have perhaps rather evaded.

There are several tolerably obvious and valuable uses which place transit by land or by sea at a disadvantage, and which may be named as follows:

(1.) Accelerated, and indeed revolutionised, mail service.

(2.) An auxiliary and formidable rival to existing means of transport—for both goods and passengers—in commerce and recreation; in the latter uses as a grand substitute for yachting, ice-sailing, mountaineering, etc.

(3.) Exploration under greatly facilitated conditions, particularly over the still extensive and hitherto impenetrable vast areas of territory in Central Australia, Africa, and over the immense trackless fields of rough "hummocky" ice within the Arctic and Antarctic circles.

(4.) Warfare on entirely new lines, so potent—not to say deadly—as to render war much less frequent than under existing conditions, if it does not prove a positive deterrent to further active international hostilities, and thus effect inestimable good to the whole world.

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* **Lancaster, of Chicago (also quoted elsewhere).**

Taking other grounds of advocacy, the Rev. Mansfield—an ardent and excellent authority in some respects, but who held regrettably unorthodox views regarding *buoyant* vessels—said: "Aerial navigation is a social problem, promising by its solution to contribute more than any other physical means to bring all mankind together."

Reverting to the belligerent and destructive uses to which the controllable aviator may be applied, Maxim wrote, in an article in *The Century Magazine* in 1891, as follows: "When the first flying machine succeeds, its first great use will be for military purposes. It will at once become an engine of war. It does not require a prophet to foresee that successful machines of this character would at once make it possible for a nation possessing them to paralyse completely an enemy by destroying in a few hours the important bridges, armouries, arsenals, gas and water works, railway stations, public buildings, etc., and that all the modern means of defence, both by land and sea, which have cost untold millions, would at once be rendered worthless."

An interesting and able leading article, "The March of Invention," which appeared in *Engineering*, April 10th, 1896, says that, "In England the two warlike devices we have most to fear are the flying machine and the submarine boat."

It would appear, however, that it is primarily a question of ownership of the devastating machine, and that if England fortunately happens to possess such machines first "the boot will be on the other leg," and foreign hostile powers will have to do the fearing. Truly there is every reason why we should be first in the field, and so may it be.

As an eminent military authority said not long ago, "The nation which is earliest to employ working aerial machines will command the warlike situation."

The following quotation from Tennyson's "Locksley Hall" bears on the question, and is interesting:

"For I dipt into the future, far as human eye could see,
Saw the vision of the world and all the wonder that would be.
Saw the heavens fill with commerce, argosies of magic sails,
Pilots of the purple twilight dropping down with costly bales.
Heard the heavens fill with shouting, then there rained a ghastly dew
From the nations' airy navies grappling in the central blue."

Is it not derogatory to the ingenuity and dignity of man that even the upstart little sparrow should continue to "have the laugh of him," lording it over the nominal "lords of creation"?

All the leading divisions of the animal kingdom have produced flying representatives, including mammals, fish, and reptiles. The genus *homo* has greatly excelled these creatures in locomotion on the land and on the water, but has not yet absolutely conquered in the air.

Aviation will probably, in the first place, form as popular (and even more exciting and exhilarating) a recreation to a select and adventurous few of the wealthy leisured classes as yachting and ballooning.

Shortly after this—the cost in the meanwhile becoming less and less prohibitive—we may see it adopted for purposes of exploration, warfare, the postal service, and commerce generally.

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## THE QUESTION OF APPLICABLE MOTORS AND ESSENTIAL FEATURES OF AN AVIATOR.

The valuable researches of Prof. Langley and others have shown pretty conclusively that the amount of power required for flight is only about two per cent. of that which was once supposed to be the minimum. The description of motive power suitable for aeronautical purposes may now be considered. The choice, at present, is confined to steam, petrol, or other spirit motors, and, under special conditions to be discussed later on, compressed air. The motors which are considered as yet to be unsuitable are high-explosive engines (gunpowder, gun-cotton, or cordite), electromotors (whether run by primary or by storage batteries), and any description of spring-driven mechanism (or enlarged clockwork).

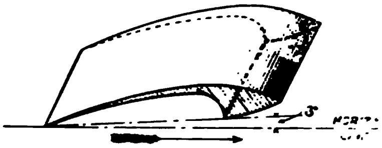

Fig. 1.

**Section of typical "Aerocurve" (of very efficient form and positive angle). Note resemblance to natural wing section.**

With regard to electromotive power, if conducting wires are led from a battery or a dynamo on the ground to an electromotor on the machine above (so as to avoid carrying the former), this does not constitute free flight at all, but a very poor substitute, and for most purposes useless.

These two latter kinds of prime-movers are at the present much heavier (having regard to *duration* of power for a given weight) than either steam engines, hydro-carbon motors, or compressed air, and, be it remembered, the latter is not so light as would appear at first thought, when one duly takes into consideration the limited duration of the charge and its total weight (including reservoir) for a given time and power.

Concerning those motors depending on the action of high explosives, to the best of the writer's knowledge and belief, nothing really practicable has yet been effected in the numerous experiments with them, nor has promise been displayed of any real future success with them.

Let it be assumed, then, that we start by using a steam motor. If this be of a rotative type, such as is required by screw-propelled machines, we have the choice of either a specially light duplex-cylinder *balanced* high-speed engine—and the writer has designed such a motor of exceeding lightness for this use (see fig. 3)—or the steam turbine, which is also perfectly balanced, and certainly appears to be peculiarly eligible. The third alternative is a petrol or spirit motor of up-to-date production, such as the admirable "Buchet" four-cylinder motor used by M. Santos-Dumont in Paris for his gas vessel. It may be mentioned here that since water-cooling is adopted with this motor, and experience has proved its necessity, it is not a lighter motor than has been produced for steam, so is not likely at present to supersede, or exclude, the latter, which has, moreover, some advantages peculiarly its own. In the non-rotative types of motor, as demanded for flapping wings, the petrol engine is clearly ineligible, as it is not admissible to use intermediate gearing.

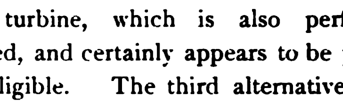

Fig. 2.

**Typical "Aeroplane" at a positive angle of inclination. NOTE.—The "Aerocurve" is more efficient at even a small negative angle than the "Aeroplane" at a positive angle.**

It is most important, if not imperative, in rotative engines for aeronautical use that there be a perfect balance of the momentum of reciprocating parts, as no vibration nor bodily swaying of the engines (and with them the whole structure) could be admitted for a moment. An *air-borne* vehicle is very delicately poised.

Reverting now to the non-rotative motor for use with wing-propelled aviators, this is preferably a trunk-cylinder, vertically placed and direct acting, connected with the wing arms (see illustration of "wave action," fig. 4), of which the writer has produced an original type, together with specially-adapted valve gear (balanced). There is an important reason for using a trunk cylinder in this type of motor, in that it admits of giving a greater wing effort on the down stroke of wings (when it is needed most) than on the return stroke, in the ratio of areas of piston $A^1$ to the annulus A (fig. 3). In both the "bird-like" and the "wave-action" machines the very ingenious appliance introduced by the late F. W. Brearey will be used. This, which he called the "pectoral cord" (fig. 3), consists of an elastic ligament or spring cord attached to the underside of the wing arms and to a fixed point below, which cord is stretched on the up-stroke of the wings *by the weight of the machine*, as the natural pectoral muscles are by the bird's gravity, and so becomes a reservoir of stored energy, ***which is given out on the next working down-stroke.***

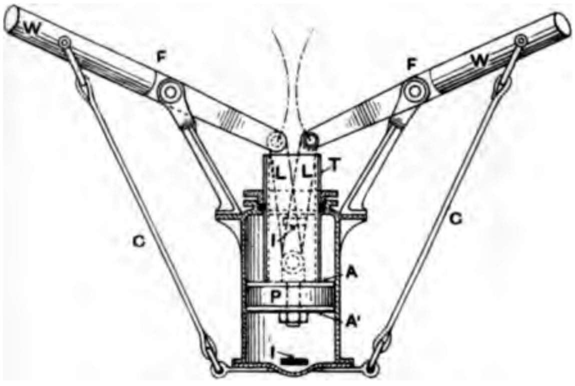

Fig. 3.

**Section of Trunk Motor (the writer claims originality for this type of motor).**

**T. Trunk.**
**P. Piston.**
**I I. Pressure Inlets.**
**L L. Connecting links.**
**F F. Fulcra.**
**W W. Wave or wing arms.**
**A and A' show the unequal effective area (and consequently unequal power exerted) on top and bottom of piston.**
**C C Pectoral cords.**

The late Mr. Brearey, in numerous lectures on flight, was enabled to demonstrate by means of this same "pectoral cord"—to the surprise of most of his audience, and the conviction of all—how a bird's gravity is a source of power to it.

The twin rotative steam motors designed and used by Mr. Maxim were, as is tolerably well known, two-cylinder compound engines of particularly light build, and constructed mainly of steel tube. The water-tube generator, besides extreme lightness, had extraordinary steaming capacity, with a very efficient hydro-carbon gas furnace, and under perfect control. This installation was well adapted for large powers, and might well be adopted again unaltered, but applied to another and better form of aviator.

To Mr. Lawrence Hargrave, of Sydney, N.S.W., is due the credit of having made and applied a suitable light modification of the "Serpollet" flashing steam generator, and with great success in several working models. This type of generator seems to be the very lightest practicable, and as it is perhaps the safest it is admirably adapted for this use. It has, however, yet to be tried for large powers.

Whether a steam engine developing a given power be small and of high speed, or large and of low speed, its boiler must be of the same capacity in either case; the boiler of a small high-speed engine, therefore, is relatively large. Although we can reduce the size and weight of the engine, and can keep the power constant, by running at higher speed and pressure, the boiler does not offer the same scope for reduction of weight. What scope there is lies principally in increasing to the utmost the effective heating surface—which means increased steaming capacity, which is the measure of a boiler's power—and in reducing to a minimum the quantity of water contained in it.

Now, the Maxim generator supplies two engines of 300 i.h.p. (aggregate), normally worked with 200 lbs. weight of contained water; while the Hargrave-Serpollet generator only contains a quantity equal to the capacity of its feed-pump, being vaporised and used as steam as fast as it is injected, and so may be said to work "hand to mouth." The supply of feed water carried need not be greater than if an ordinary type of boiler were used.

Although it has been found advantageous to run aerial engines at high pressure and non-condensing (non-condensing as far as an absence of vacuum is concerned) to avoid carrying such weighty adjuncts as air-pump and circulating pump, or else air-pump and jet condenser, with injection water, etc., it is a distinct advantage to recover the water of condensation from the exhaust for re-use, thus greatly reducing the quantity of feed water it is necessary to carry for a given duration of flight. For this purpose an air-surface condenser (open) should be employed, such as that used on the Maxim machine, in which it formed the forward portion of the main aeroplane.

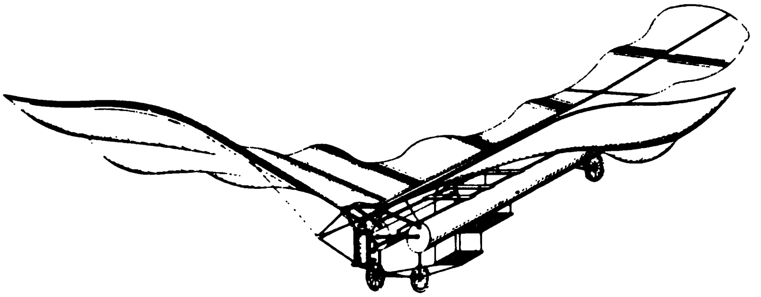

Fig. 4.
"Wave-action" type of Aviator (Brearey's), shown fitted with a motor of the writer's design, together with twin compressed-air reservoirs and pectoral cords.

In the recent designing of torpedo-destroyer machinery much attention has been paid to obtaining combined power, lightness, and strength, particularly since the adoption of the steam turbine, with admirable results, and yet even this does not approach the degree of lightness necessary for aerial locomotion.

The lighter the source of power can be made the smaller will be the practicable scale on which the machine may be constructed, or the larger will be the margin available for surplus weight carrying. The proportion of power to total weight of machine should not be less than one brake horse-power per 50 lbs. for screw-propelled aerocurves, and not less than one brake horse-power per 75 lbs. for either the "bird" or the "wave-action" types. Of sustaining surface not less than seventy square feet per 50 lbs. must be provided; but for the necessity of parachutic effect in descent half this surface would suffice.

The essential features of a practicable, safe, and useful aerial vehicle are:

(1.) The ability to raise itself and freight, either from a level track after a short initial run (being on wheels) or by gravity after running down a gentle slope or inclined staging near the ground.

(2.) The ability to propel itself in any desired direction, and be practically unobstructed by an average wind.

(3.) To offer but comparatively small *obstructive* surface to the air or the winds.

(4.) To be so constructed and poised, and to have such stability, that it cannot capsize nor fall precipitately, the latter contingency being guarded against by providing adequate sustaining surface for parachutic descent. To provide stability the sustaining surfaces should be in two rather widely-detached blocks, longitudinally, and at "diedral" angles transversely, besides which the centre of gravity must be kept fairly low.

(5.) The generator furnace (in steam) to be so enclosed and under control, as regards both fuel and air supply, that the fire can be regulated to a nicety or instantly extinguished.

(6.) Lastly, the machine should be capable of a speed favourably comparable with the fastest land vehicles. It is not expected that a hundred miles or more per hour will be attained. The gain will be mainly in going by the shortest cut to any desired place.

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### THE QUESTIONS OF DESIGN AND TYPE OF AVIATOR.

It has been well and truly remarked that the absence of intelligent control in a *model* aerial machine necessarily places it at a great *disadvantage* as compared with a large practicable machine carrying one or more passengers, so it is presumably an easier matter to realise true controllable flight with an aviator of larger growth than with a model. However, the fact must not be overlooked, nor underrated, that valuable experiments have been, and still may be, made with working models, which have the further advantages of being comparatively inexpensive and portable, remembering, too, that magnitude does not affect principles.

The late Mr. F. W. Brearey, B.Sc., the eminent authority, once said: "The effective action of models carrying weights in the air should be looked upon with hope."

In the designing and construction of aerial apparatus one should not depend so much on light materials as on a judicious general lightness of design, that is, the selection of the strongest available materials so disposed as to reduce the quantity used to a minimum.

The observance of directness and continuity of working stresses, and the strict avoidance of *compressive* stresses wherever practicable, are highly conducive to lightness. There is great advantage in adopting a system of *tension*, staying with steel piano wire (which has a tensile strength, absolute, of 120 tons per square inch of section).

The praises of pure aluminium as *the* very material for aerial machines have been loudly sung. Far too loudly, as, although it is true it has a specific gravity of only 2.5, its advocates forget, or do not know, that it has only about the same strength as copper and works like lead. Judiciously alloyed, however—in which its weight is not now greatly increased—it is valuable for castings, particularly for motor crank casings and fittings, etc. Nickel steel is, seemingly, the best material for any structural purpose in which the greatest strength is imperative for a given weight.

Many years ago the writer shared in the popular delusion about aluminium as a structural material (no light useful alloys of it had then been produced), so he bought a few ounces of sheet aluminium (it was then 7s. 6d. per ounce) and constructed the frames of two model aerial motors therewith.

In order to get sufficient rigidity he then found that a considerable quantity of this material had to be used, inasmuch as a third similar model he afterwards made with a framing of thin sheet steel came slightly lighter with greater rigidity.

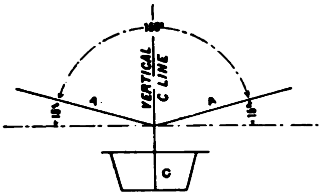


Fig. 5.

Diagram showing "diedral" angle of sustaining surfaces transversely with horizon.

A A Sustaining surfaces (end on). C Car and platform.

Let us now consider the most practicable types of flying machines. Those available may be named as follow:

(1.) The purely "bird" type of machine, with suitably-shaped pointed wings, sweeping through wide arcs, and with a wide expanse of horizontal sustaining surface.

(2.) The "wave action" type (see illustration), which is analogous to the bat's wing action, and to the undulatory progress of the skate and other flat fish, possesses vibrating wave-arms (moving through shorter arcs than in the foregoing), to which is attached the leading edge of a horizontal web or membrane of slightly variable inclination, which membrane is put into vigorous undulation thereby, and so becomes a propeller sustainer.

(3.) The screw-propelled "aerocurve" (not aeroplane), or, preferably, series of "aerocurves," arranged in two detached groups, pretty widely separated fore and aft, and driven by twin right and left-hand screws.

(4.) A similar machine to the last named, but propelled and sustained by the reaction of jets of steam or other fluid pressure ejected rearwardly.

(5.) The machine depending solely on elevating and propelling screws, vertically and horizontally acting respectively.

Of these five types of machine the writer's preference is for the first and third named. These will now be more fully described, as their respective motors have already been. The "bird" type, in common with the "wave-action," has one notable advantage over the other types, in its exceeding simplicity, both of the machine as a whole and of the motor apart. This machine will preferably have its pair of long, narrow, and pointed wings placed about midway in its length between two pairs of *fixed* sustaining wings front and rear, these being set at a slightly upward or "diedral" angle. A centrally suspended boat-like car will take the place of the bird's body.

Its steam motor is of the simplest possible type, being non-rotative, and acting directly on to the wing arms. The valve gear is of a simple "tappet" variety, with an equally simple and efficient balanced pressure distributing valve, provided also with hand-working gear. This new valve and gear are of the writer's own design, and have been found to work very efficiently in model motors.

Both the fixed and the flapping wings will be membranes of varnished holland strained on frames of very light and tapered steel tube, and trussed with steel wire. The fixed sustaining wings subtend an angle of about 150° transversely—the "diedral" angle (see fig. 5)—which very efficiently provides transverse stability.

The car or platform, mounted on four very light wheels, may be simply a plain flush open platform or wood grating, either with or without a punt-shaped wicker substructure covered with varnished canvas, after the fashion of the ancient coracles, and adapted to take the water.

In short, the general arrangement and form of this machine will resemble the Langley "Aerodrome" (see fig. 6), except that a pair of bird-like wings will take the place of the twin screw-propellers amidships.

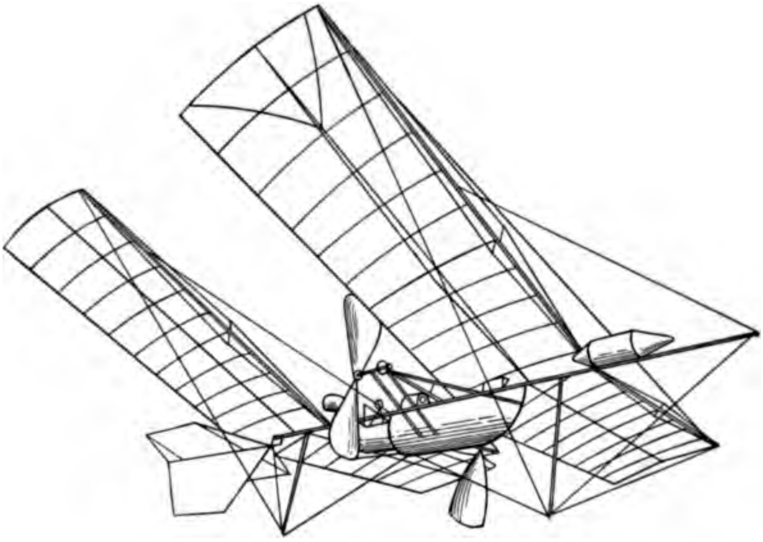


Fig. 6.

**Professor Langley's Steam "Aerodrome." NOTE.—This machine has flown for a distance of threequarters of a mile by steam power alone in a rising course, and came down safely.**

The steam generator will be either of a specially light water-tube type, with abundant heating surface, oil gas fuel, feed heater, and, preferably too, a forced circulation, as developed and used by Mr. Maxim; or a light modification of the "Serpollet" instantaneous or "flashing" steam generator, also fired as above with a "Bunsen" type of furnace, as used successfully in model machines by Mr. Lawrence Hargrave.

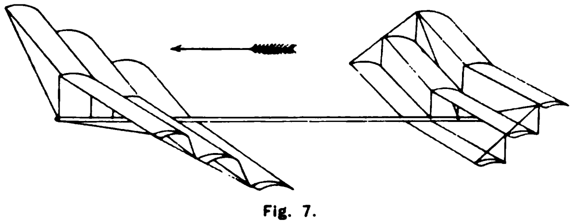


Fig. 7.

**Arrangement of stepped "Aerocurves" (the writer claims entire originality for this system). It is not restricted to three steps.**

As an alternative method of firing to the above, the liquid hydrocarbon may be blown into the furnace and burnt as spray, which will dispense with the gas-generating plant, but this is neither so economical as the gas (which is diluted with a quantity of air), so free from smoke, nor so clean. All other fuels may be said to be out of the question for this use. The steam generator with its accessories, as above described, will be practically the same for the other types of machine.

The twin-screw propelled "aerocurve" machine will consist essentially of a considerable total expanse of sustaining surface, but not continuous. There will be four detached sets of aerocurves, and these will not be, properly speaking, superposed (as they are in the Hargrave-Chanute soaring machine), but will be *stepped* (see figs. 7 and 8), so that the whole of the surface will be available for parachutic action in checking descent, which would not be the case if they were superposed or vertically above each other. Relatively narrow aerocurves, when so stepped, are far more efficient, when travelling horizontally, or in a horizontal wind, than a continuous aeroplane of the same total width and length. These four (two abreast) sets of fixed wing aerocurves will respectively be arranged at "diedral" angles to each other, as in the Langley "Aerodrome" (see illustration and fig. 6), to give transverse stability. The detached positions of the two pairs of sets of aerocurves, fore and aft, provide longitudinal stability.

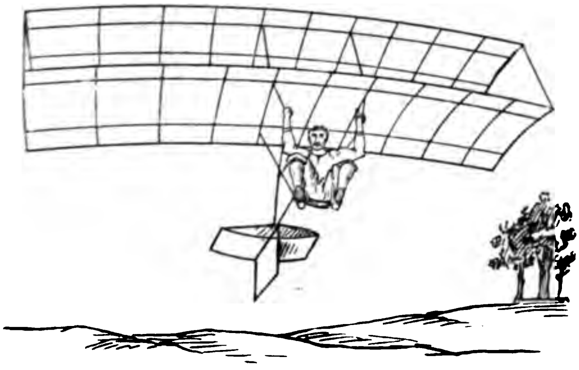


Fig. 8.
Hargrave-Chanute "Two-decker" Soaring Machine.

The minimum distance between centres of twin-propellers will be slightly greater than their diameter, and a compound T-section tail rudder will be fitted, as in the "Aerodrome." As in that machine also, the propeller shafts may be carried on outriggers. Steering may be effected by varying the speeds of the two propellers, by using independent motors. That beautiful and successful machine, the "Aerodrome," of Prof. Langley, is so illustrated as to need little further description. Its dimensions are 15ft. x 14ft., the diameter of propellers (right and left) being 39in. The weight of motor and generator complete is 7 lbs., and 1½ h.p. was developed on trial. The total weight of machine is 29½ lbs. The steam generator (weighing 5⅛ lbs.) is formed of a continuous coil of ⅜in. copper tubing, and is heated by a pressure blast flame.

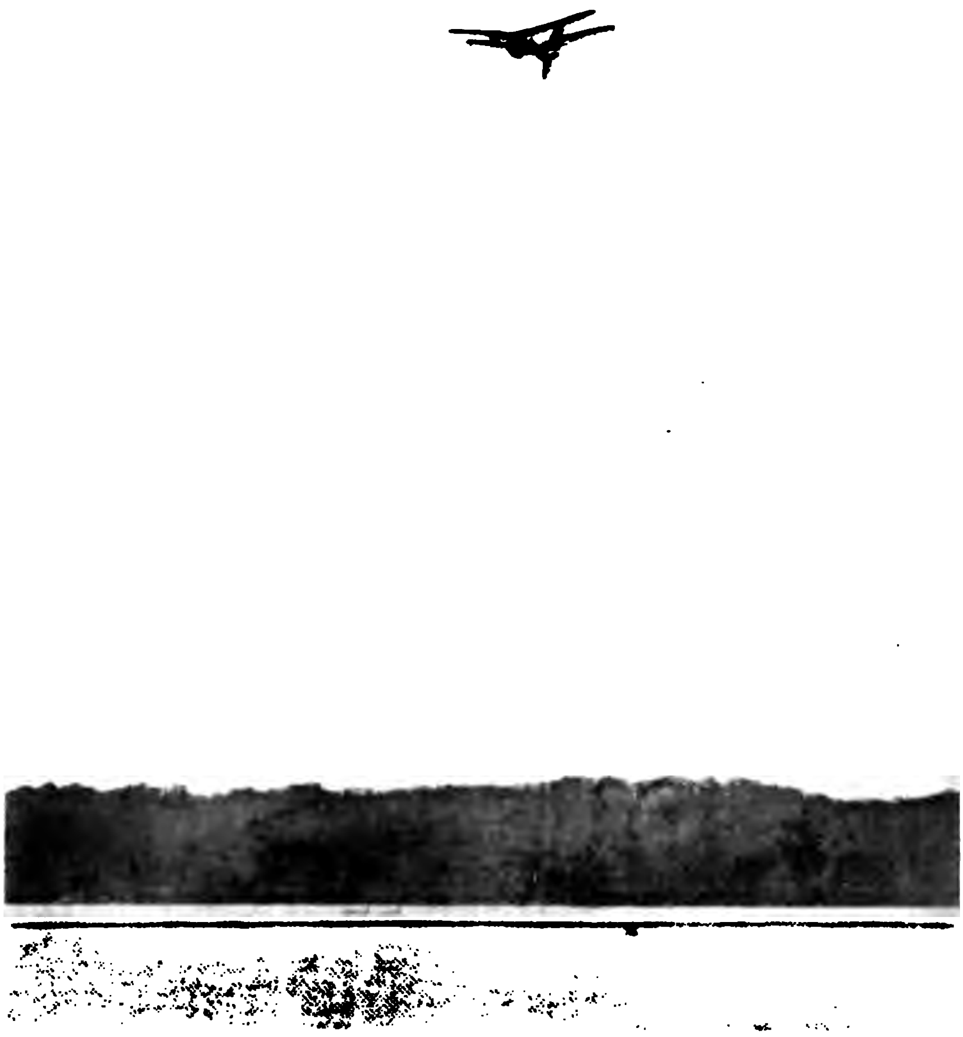
The system of vertical lifting screws is an impracticable one, requiring very much greater power than the other systems, and therefore may be dismissed briefly.

OCTAVE CHANUTE, C.E.

LAURENCE HARGRAVE.

HIRAM S. MAXIM.

## LANGLEY'S AERODROME No. 5.



In flight, May 6th, 1896.

# Some New Motor Balloons.

THE new balloon being constructed in Paris to the designs of M. Augusto Severo differs entirely from that of M. Santos-Dumont as well in the form of the aerostat, the method of attaching the keel, and the arrangement for driving and steering it. The aerostat is of about the same length, but the diameter is double, being 39ft. instead of 19½ft.; while the keel, which is built up of steel tubes and aluminium, is attached directly to the balloon. There is a motor at each end of the keel—one of 20 h.p. weighing 352 lbs., and the other of 16 h.p. weighing 220 lbs. The motors are geared directly to the propellers without the intervention of long shafts, the one in front being intended principally to create a displacement of air, which, it is claimed, will partly overcome its resistance to the balloon, while the rear propeller serves to drive the machine. The apparatus is steered by two other propellers—one at each end—placed perpendicularly to the axis of the balloon, that is to say, they work at right angles to the driving propeller, and give to the balloon a circular motion. It is easy to understand that with this system the balloon can be turned in its own length and at almost any speed. The rudder is dispensed with, and M. Severo claims that his system gives the greatest stability, and entirely overcomes the see-saw motion which has proved to be a serious difficulty in the driving of motor balloons. M. Severo has been engaged for twenty years upon aerial navigation, and in 1892 he carried out some trials with a balloon named the "Bartholomeu de Gusmao," after a Brazilian priest, who invented a flying machine in the sixteenth century, and on the balloon being destroyed by a storm he abandoned his experiments until the attempts of M. Santos-Dumont induced him to give further attention to the matter. As member of the Brazilian Parliament, M. Severo introduced the proposal for granting M. Santos-Dumont a sum of £11,200 as a contribution towards his expenses, and though the amount does not seem to have been voted, the Government has recently granted £5,000, and has ordered a gold commemorative medal to be struck for M. Santos-Dumont. While M. Severo has given every encouragement to his rival, he is by no means of the opinion that the Santos-Dumont balloon has successfully solved the problem of aerial navigation, and finding that he could not carry out his projects in Brazil he went to Paris, and placed an order for the balloon which he has christened the "Pax." Another balloon is now in course of construction at Schio in Italy. The plans have been made by Count Almerico, who is combining his own long experience in aerial navigation with the scientific researches of a mathematician, Pasquale Cordenons. About twenty years ago Cordenons presented plans for a motor balloon, which were approved of by the Minister of War, but the death of the inventor put an end to its construction. The work is now being continued by a company, which has been formed under the patronage of the Government. The balloon of Count Almerico will have a length of 108ft., and the largest diameter will be 19½ft., thus giving it a capacity of 600 cubic metres.

The keel, pointed at each end, is to be constructed of aluminium tubes or cylinders welded by a special process. It will have a length of 55ft. 6in., and a depth and width of 3ft. 3in. It will carry three seats on the top. During the trials Count Almerico will use a horizontal motor of 3 h.p. for driving the large propeller at the end of the keel, but he will afterwards fit a 6 h.p. vertical engine. Count Almerico expects to be able to drive his balloon at the rate of twelve miles an hour, but it will have to be driven at twice this speed if it is to be anything like a success. The new airship (Santos-Dumont No. 7) which is being built by M. Santos-Dumont is being put together in a shed, which is being specially built by and at the cost of the Prince of Monaco. The statement which was made in one of the newspapers to the effect that the Prince of Monaco is to build a balloon is incorrect. The balloon is being constructed at the works of Lachambre. The length will be seventy-nine metres, and it will have a cone at each end. It will have a volume of 1,257 cubic metres. The envelope is to be constructed of two layers of silk closely stuck together. The balloon is to be driven by two Buchet motors of 40 h.p. each, weighing 160 kilos. The two propellers are five metres in diameter. M. Santos-Dumont expects to attain a speed of seventy kiloms. an hour. The balloon will be finished in January, and M. Santos-Dumont hopes to make the journey from Monaco to Corsica and back at the beginning of February

# The Aeronautical Society.

THE Aeronautical Society of Great Britain was founded on January 12th, 1866, on which date a group of men, including some of the most eminent scientists of the day, met together at the house of the Duke of Argyll, for the purpose of establishing a society "for the advancement of aerial navigation and for observations in aerology connected therewith." The Duke of Argyll was elected president, the vice-presidents being the Duke of Sutherland, Lord Stalbridge, and Lord Dufferin. The council included such men as Sir Charles Bright, M.P., Dr. (afterwards Sir William) Fairbairn, Sir C. W. Siemens, Mr. Glaisher, and many other well-known gentlemen. Mr. F. W. Brearey was the first honorary secretary. On June 20th, the initial meeting was held, when a very interesting paper on "Aerial Locomotion" was read by Mr. F. H. Wenham.

The society made very satisfactory headway in 1867, two meetings being held. Its membership had grown from sixty-five to ninety-one—a number which, in the third year of its existence, was increased to 106.

In 1868 the society made a very important move; it instituted an exhibition "for the purpose of giving wide publicity to the suggestions and form of machines proposed by different inventors." This exhibition opened at the Crystal Palace on June 25th, and numerous models were shown. The light high power engines were probably the most important section of exhibits, a prize of £100 having been offered by the society for the best shown. Sixteen models were exhibited, and the prize was awarded to Mr. Stringfellow, whose steam engine, giving rather more than 1 h.p., only weighed 13 lbs. with boiler

The society continued to gather strength, and in 1873 it conducted some interesting experiments in aerodynamics by means of a powerful current of air driven through a tube.

After this, less interest appeared to be taken in the society, and the membership gradually declined — a state of affairs which was largely due to the fact that Mr. Brearey, the honorary secretary, was a very old man, and was unable to impart much life into the steadily declining institution. Indeed, after his death it appeared as if the society must die with him. However, it lingered on, and on November 30th, 1896, a few members of the council met together, and after fully discussing the position of affairs, it was decided to try and resuscitate the institution.

Meanwhile, much had been done in this branch of science outside the society. Maxim's great machine had been built, and had attracted much attention. Lilienthal in Germany had aroused public interest in his soaring experiments, whilst Langley, in America, had conducted a remarkable series of experiments in aerodynamics. Chanute, too, had brought out his book, "Progress in Flying Machines," which was practically the first really good and complete account of the subject ever published. All this caused a greater interest in aeronautics, and the result was the efforts of the council to arouse the society from its moribund condition were completely successful, and new members [illegible] At the present [illegible]

London, the following subjects were dealt with before a large company: "Aerial Navigation by Bodies Heavier than the Air," by Sir Hiram Maxim. "Atmospheric Currents," by Mr. William Marriott, assistant secretary Royal Meteorological Society (illustrated by lantern slides). "Navigable Balloons and the Scientific Aspects of M. Santos-Dumont's Experiments," by Eric Stuart Bruce, M.A. (illustrated by experiments and lantern slides). A full report of this meeting appears on another page. The present honorary secretary of the society is Mr. Eric Stuart Bruce, M.A., 19, Campden House Road, Kensington, W.

## The Inventor of the Balloon.

It is perhaps not generally known that Montgolfier, the inventor of the balloon, owed his success to observing smoke ascend. His idea was that if he filled a bag with smoke the bag would ascend, and in doing so he of course filled the bag with hot air, hence his experiment was successful.

## A Large Prize.

Everyone has heard recently, in connection with M. Santos-Dumont's exploits, of the prize of £4,000 offered by M. Deutsch for the most navigable airship. Few people, however, know that had Dumont been of British birth he might have also been entitled to a reward of £12,000 on account of his remarkable achievement. The latter prize is known to aeronauts of this country as the "Me[illegible]n-Payne" legacy, which was left by the famous amateur balloonist of that name, to be awarded to the first British subject who invented a practicable navigable airship. Several attempts have been made to win this prize, [illegible] but up to the present [illegible]

# The Aero Club.

THE interest in matters aeronautical has recently become so very wide —a state of affairs largely brought about, no doubt, by the daring exploits of M. Santos-Dumont—that it is not surprising that the Automobile Club should establish a "flying" section, more especially as modern aerial machines are closely connected with automobiles, owing to the fact that, to a large extent, the motive power is the same. That the club will be a great success there is not the slightest doubt, for already over two hundred gentlemen have applied for membership, and it will not be long before this number will be trebled. The club is open to ladies and gentlemen subject to election.

In justice to the founders of the Aero Club of the United Kingdom, the fact should be put on record that, as is often the case in regard to inventions, two groups of gentlemen were engaged at the same time in preparing the announcement of the same thing, and, as is also the case in inventions, the honour of the novelty rests with the person who first registers it and makes it public.

Mr. Frank Butler and the Hon. C. S. Rolls decided whilst engaged in a balloon ascent on September 24th to form an Aero Club. On October 21st the Standing Committee of the Automobile Club approved of the idea, and gave the secretary directions to assist in the formation of the club.

The Aero Club of the United Kingdom, Ltd., was registered at Somerset House on Tuesday, October 29th, and on the following day 260 copies of the prospectus of the club were posted to gentlemen who it was thought might possibly join. The Aero Club of the United Kingdom was advertised in the *Times* on Thursday, Oct. 31st, and it was not, however, until Friday, Nov. 1st, that the scheme for the Aero Club of Great Britain and Ireland, which had been contemplated by Mr. Simms and a number of influential gentlemen, was made public. Messrs. Rolls and Butler were the first in the field publicly, though we believe Mr. F. R. Simms was as early, if not earlier, so far as private action in the matter was concerned. Mr. Simms at once dropped his proposed society, and became a founder member of the Aero Club. The Aero Club of the United Kingdom is registered under the Companies Act, by which the liability of a member is restricted to his subscription and to a share of one shilling.

Its purpose is for the encouragement of ballooning as a sport, and of aerial locomotion in all its forms and applications. It is intended—

*(a)* To encourage the study of aeronautics and develop the sciences connected therewith.

*(b)* To organise aerial excursions in which all members may take part.

*(c)* To organise congresses, exhibitions, races, and contests.

*(d)* To acquire balloons for the use of members.

*(e)* To acquire premises, to form a library, and to promote intercourse between those interested in the subject.

*(f)* To engage a competent aeronaut for the conducting of aerial excursions, and for the education of members.

*(g)* To acquire the use of grounds for inflation of balloons and for ascents.

*(h)* To grant certificates of competency to members, who having made a sufficiency of ascents, are recognised as competent to take control of a balloon.

It is suggested that—

*(a)* At the outset a balloon should be acquired for the use of members.

*(b)* Ascents should be confined to members of the club.

*(c)* Ascents should be made weekly, or periodically, according to demand.

*(d)* The charge for ascents should be in accordance with the cost and the time of the year.

*(e)* Dates for ascents should be by ballot.

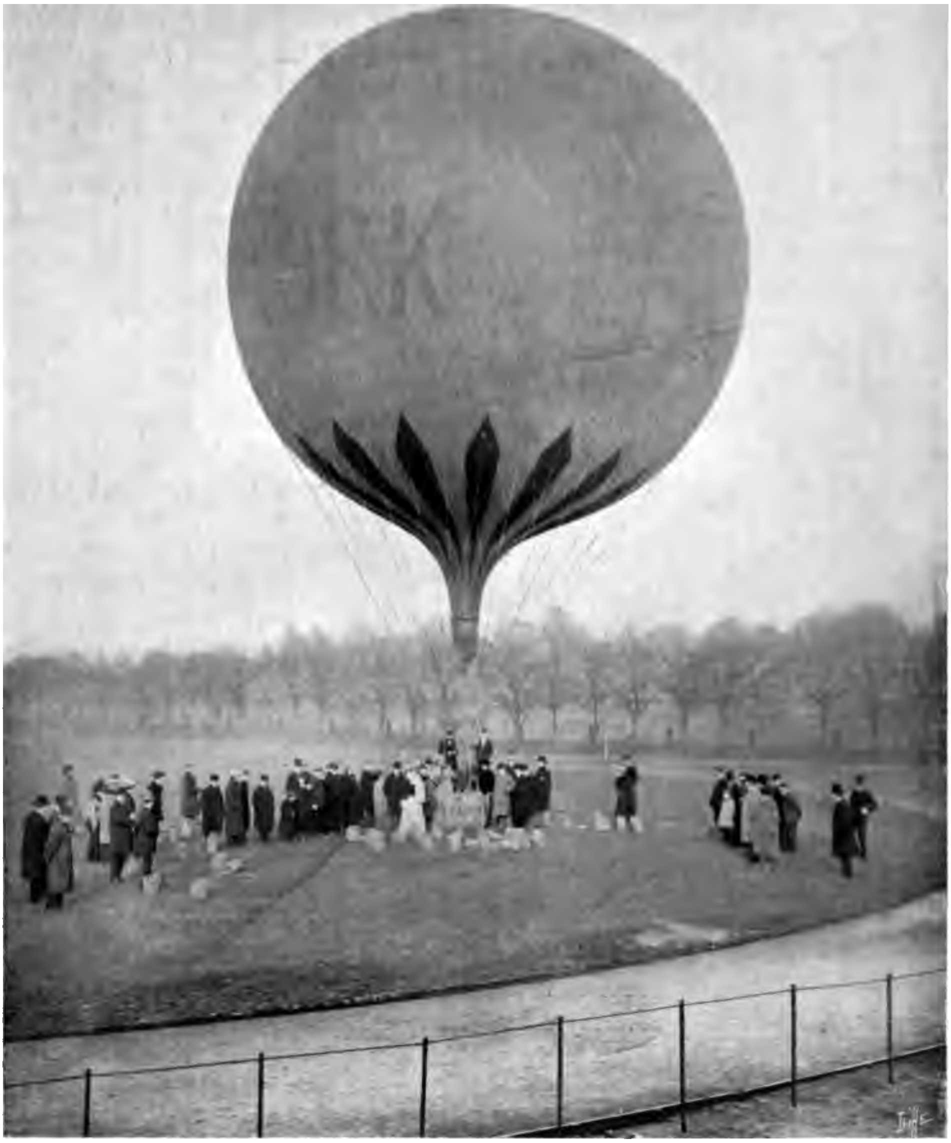
A largely-attended meeting of those who have already enrolled their names as candidates for the Aero Club was held at the Automobile Club on Tuesday evening, Dec. 3rd, Sir V. K. Barrington presiding. The following gentlemen were elected a provisional organising committee, pending the election of the club officers in 1902 after the first election of members: Mr. Campbell Muir, Captain Laycock, Mr. Mark Mayhew, L.C.C., the Hon. John Scott Montagu, M.P., Mr. Hugh Weguelin, Mr. A. M. Singer, Mr. Frank H. Butler, Mr. Roger W. Wallace, K.C., Dr. F. W. H. Hutchinson, Sir Claude de Crespigny, Bart., Lieut. Spaight, Mr. A. Paget, Col. Templer, Mr. Paris Singer, the Hon. C. S. Rolls, Mr. Neptune Blood, Sir V. Kennett Barrington, Bart., Mr. Patrick Alexander, Mr. Pollock, Sir David Salomons, Bart., Mr. Claude Crompton, Col. R. E. B. Crompton, R.E., Major Trollope, Dr. Boverton Redwood, and Mr. B. Redwood. The election of a balloon committee was deferred. The secretary *pro tem.* is Mr. C. Johnson, and the address of the club is 4, Whitehall Court, S.W.

# First Ascent of the Aero Club.

On Friday, November 15th, Mr. Frank H. Butler and Miss Vera Butler made an ascent from the Stamford Bridge Grounds in the balloon "City of York," the aeronaut being Mr. Spencer. The morning was extremely fine but cold. The Hon. C. S. Rolls was to have been one of the party, but owing to the heavy gas supplied, the balloon would only lift three persons, and Mr. Rolls gave up his place.

The ascent was witnessed by a number of candidates for membership of the Aero Club, including Mr. Willoughby, who was driving his New Orleans car; Mr. T. B. Browne, on his James and Browne car: Mrs. T. B. Browne, on her Renault; Mr. W. J. Peall, on his 12 h.p. Daimler; and Mr. and Mrs. C. Johnson, on their 7 h.p. New Orleans. There were also present Mr. Alfred Bird, Mr. Robert Bird, and many others. As the balloon left the ground a biograph was taken. A flag, thirty feet long, hung from the basket of the balloon bearing the words, "Aero Club." The balloon rose to a height of 10,000 feet, and descended near Maidstone the same afternoon.

*Argent Archer. Photo.*

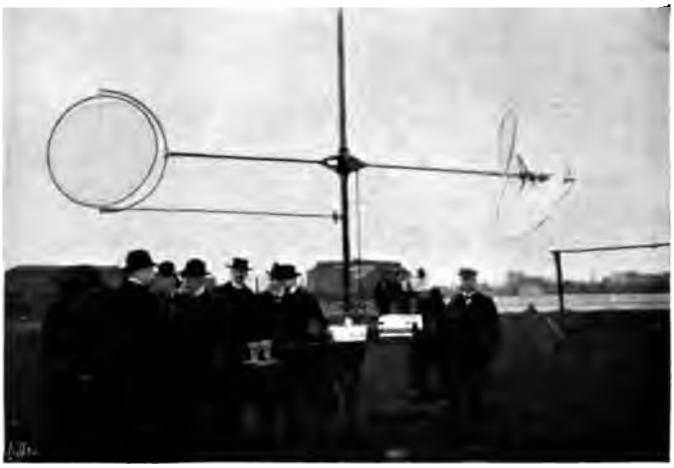


*Argent Archer, High Street, Kensington.*

THE FIRST ASCENT OF THE AERO CLUB.

# Trials of Flying Machines in Paris.

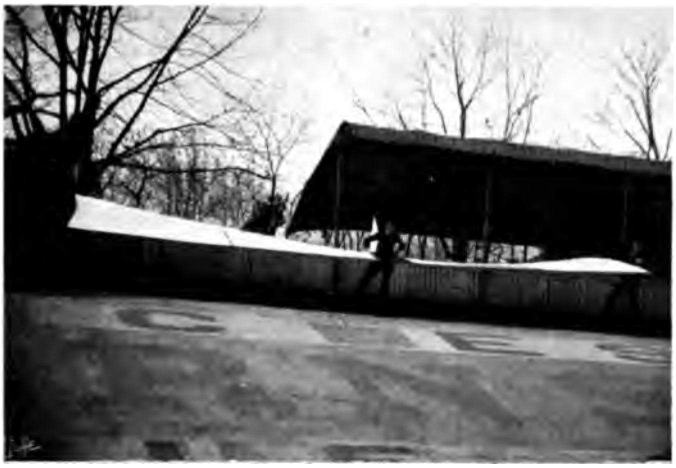
NO event has attracted more interest in aerial navigation matters than the trials of flying machines and kindred apparatus that were organised by MM. Delagneau on the Parc des Princes grounds in the second week in November. The constitution of the committee—composed as it was of many eminent scientists, engineers, and aeronauts—shows to what extent the problem of true flight has become the object of serious investigation, and interest in the trials was all the keener because it was hoped they would be the foundation of a science in which there is at present absolutely no trustworthy data. All the inventors are planning their machines from theoretical deductions, and though there are cases of men flying certain distances, the partial success of their efforts has been of little practical value, beyond showing that the problem of true flight is really capable of solution, and is not the visionary dream it has been made out to be up to within quite recent times. In promoting their trials, MM. Delagneau were anxious to test all the different methods of moving through or keeping up in the air, from the kite and the toy bird to the real flying machine, in the hope that by comparing all the various principles employed something would be done for the advancement of aerial automobilism. The apparatus were divided into several classes, according to whether they rose by the action of the wind against an inclined plane, such, for example, as the kite, or whether they were raised by motive power or depended for their flight upon the skimming of aeroplanes. By far the great majority of the apparatus were in the first class, and the work of the judges was devoted almost entirely to testing kites of every possible shape and examining the behaviour of birds and other mechanical toys, which were presented by the score. The kites were again divided into the toy and scientific varieties, and owing to the heavy rains on Nov. 6th, when only one kite was able to stay up in the air for more than the allotted half-hour, the trials of the scientific kites had to be postponed. This test, however, offers little of interest to aviators, since the angle at which inclined planes held by a string will rise can do nothing to help forward aerial navigation, and scientific kites are only



THE VILLARD FLYING MACHINE.

useful for meteorological purposes. In the numerous examples of toy birds and flying apparatus there was little novelty, and they were only remarkable in most cases by the readiness with which they succumbed to the law of gravitation.

Most interest was naturally centred in the two big flying machines of M. Demouveaux and M. Villard. The former was an aeroplane upon the same principle as that with which Herr Lilienthal carried out his experiments. This consists of two long planes upon a bamboo framework, and joined by a square frame which passes over the body of the aviator. M. Demouveaux had announced his intention of jumping from the top of the stand and flying to a given point inside the velodrome, but before undertaking this dangerous experiment he made a trial on the following morning from the top of the cycle track at the bend. Passing the frame over his body, M. Demouveaux suspended it over his shoulders by cords, and attached to his legs two other cords, which were fastened underneath the aeroplane at either end. At his back was a small rudder or wing operated by cords on the arms. In flying he intended to jump from the top of the inclined track, and by means of the cords attached to his legs give rapid vertical movements to the planes while they skimmed through the air. What actually happened was that he failed to rise at all, and slipping down to the bottom of the cement track broke one of the bamboo frames. The attempt to jump from the top of the stand was therefore abandoned—fortunately for M. Demouveaux, whose machine, as at present constructed, is obviously utterly incapable of supporting a man in the air.



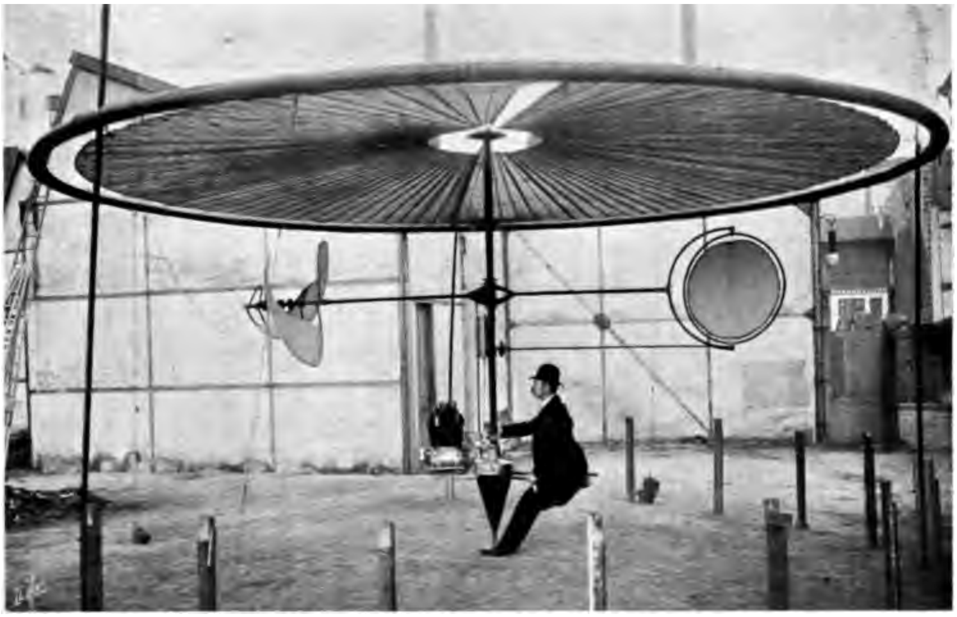
THE DEMOUVEAUX FLYING MACHINE.

The flying machine of M. Villard is of a much more serious character, but whether it is more practical has yet to be proved, for he was unable to carry out any experiments with the others. A solid steel cone, of which the apex is fixed in an iron stand to keep it in a vertical position on the ground, carries a long vertical tube, inside of which revolves a shaft. At one side of the inverted base of the cone is a two-cylinder Buchet motor of 14 h.p., which gears on to the bottom of the shaft, and at the opposite side of the cone are two heavy rods, upon which a seat is placed for the driver. At the top of the shaft is fixed a huge parachute 23ft. in diameter. Unfortunately, this parachute was not shown on the machine, and it was through the impossibility of getting it to the grounds in time that M. Villard was unable to make any experiments, though even if he had shown his machine complete the War authorities had refused his request to allow him to fly around the fortifications.

From what we could ascertain, the parachute combines the principles of the cone, the fan, and the gyroscope, that is to say, it displaces the air by horizontal revolutions with sufficient force to raise the machine and the driver, while the considerable periphery speed gives to the machine the required stability in any wind, and its conical form allows of it falling slowly in the event of the motor ceasing to work. Being raised by the gyroscope the machine is propelled by a two-thread screw at the end of a horizontal rod half-way up the vertical tube, and gearing on another vertical shaft which takes the drive from the motor-shaft. In the same axis as the horizontal shaft carrying the propeller is another rod with a semi-circular piece, in which revolves the circular rudder, which is operated in any direction by a parallel rod within reach of the driver. The rudder is of the same diameter as the propeller, so that in the forward movement a column of air strikes the rudder, and a slight vertical inclination is thus sufficient to change the direction of the machine. In the absence of any counter force it would seem as if the gyroscopic movement of the parachute would cause the machine to revolve in the air, and M. Villard admits that this has to be taken into account when steering it, but after all it is impossible to say how the machine would act except by practical experiment. M. Villard states that a model of the machine has worked perfectly. Its weight is 350 kilos., so that with the driver the total weight to be raised would be more than 400 kilos. It is an extremely novel and ingenious machine, and has been worked out to very close calculation, and trials which are to be made shortly will, at all events, show what reliance can be placed on the combined principle of the parachute, gyroscope, and fan.

The only other thing exhibited of interest to aerial automobilists was a new propeller invented by M. Schutz. With a view of avoiding the cumbersome propeller required on motor balloons, he uses textile material, which is fastened to the wood or metallic parts near the shaft. When the shaft revolves the textile pieces, which are loaded at the ends with lead, fly out and revolve in a perfectly horizontal plane. This, of course, makes it utterly useless for propelling a machine. To sum up the trials, it may be said that while the performances of the kites may prove interesting from a scientific point of view, the abstention of the flying machines was disappointing, and in the absence of experiments with such mechanism they have given absolutely no practical results. The only outcome of the trials is the Villard machine, which involves an entirely new

AN UNSUCCESSFUL EXPERIMENT WITH THE DEMOUVEAUX.



M. VILLARD'S APPARATUS.

principle in flying mechanism, but whether the principle is a good one has yet to be proved. In any event, it may be taken for granted that the trials will become periodical, when every encouragement will be given inventors to bring out practical machines. Much could not be expected from the first series of trials.

## An Interesting Experiment.

The first living things to ascend in the air in a balloon were a sheep, a cock, and a duck. They landed safely, after a journey of two miles, which was accomplished in ten minutes. This experiment took place in France in 1783, the ascent being watched by the king. It was engineered by the ever-famous Montgolfier, who, with his brother, a few months earlier had discovered that a bag filled with hot air would ascend. Hydrogen gas was substituted for hot air in the ascent above referred to.

## Balloon Chasing.

### A New Form of Sport.

Balloon chasing by autocarists is the latest sporting fancy of our lively Gallic neighbours. From the description of a recent classic event, however, in which the balloon ascended from Bordeaux and sailed imperturbably to a spot forty miles from the start, it would appear that the fun hardly lies with the groundlings. "As the crow flies" is a bit rough on automobilists, although one of them was duly medalled for being in at the descent.

# The British Aeronautical Society.

OPENING OF THE SESSION—PAPERS BY SIR HIRAM MAXIM, MR. WM. MARRIOTT, AND MR. ERIC S. BRUCE.

THE opening meeting of the session of the British Aeronautical Society was held at the Society of Arts rooms, John Street, Adelphi, on Tuesday evening, December 3rd, when three papers were contributed to the proceedings. The chair was taken by Mr. E. P. Frost, and there was a fairly large attendance.

### BUSINESS MATTERS.

The Chairman, in opening, expressed the regret they all felt at the absence of their president, who had done, and was doing, so much for the society in South Africa. He then called upon

The Honorary Secretary (Mr. Eric Stuart Bruce), who, after reading the minutes of the last meeting, stated that during the past financial year the receipts had been £233 12s. 7d., and the expenditure £89 15s. 3½d., leaving a balance of £143 17s. 3½d. The Honorary Secretary also read a portion of a letter from Commander Scott (who was at present in charge of the Antarctic expedition) concerning his hopes of success in the use of a balloon in connection with that expedition. He (the honorary secretary) urged upon Commander Scott, on behalf of that society, the importance of taking a balloon with him, and this letter was in answer to those representations. Commander Scott said a balloon if used at all could only be used by any possibility on a particularly fine day, which was likely to be a very rare occurrence. An ascent, even for a few hours, would be fraught with results of great importance, and though such an ascent would be attended with very great difficulties the possibilities were such that the trial was worth the making, even at the expense of the weight carried.

The Chairman, before introducing Sir Hiram Maxim, referred to the cordial relationship existing between this society and the French Aeronautical Society, as evidenced by the visit paid last year by the president of the French society (through the good offices of the honorary secretary) to read a paper on "Balloons and Ballooning in France." Another distinguished feature he might mention was Col. Templer's reply to enquiries made by this society as to the use of balloons in the South African War. Col. Templer said the balloons were "magnificently successful." In any part of the globe—civilised or uncivilised—he (the chairman) thought it would be unnecessary to introduce a man so eminent and well known as Sir Hiram Maxim—(applause)—and as they were all eager to hear what he had to say, so far as his voice would allow—for Sir Hiram informed him that he had a sore throat—he would call upon him without further preliminary to read his paper.

Sir Hiram Maxim, who was received with applause, said that owing to his sore throat it would be impossible for him to say a great deal, and he thought it best to ask Mr. Bruce to read the paper which he had prepared, so that he could reserve what little voice he had left for the discussion which would probably follow, and for explaining the lantern slides which would be shown.

The Honorary Secretary then read the paper, which was entitled

### "AERIAL NAVIGATION BY BODIES HEAVIER THAN THE AIR."

At the outset the paper pointed out some of the difficulties which stood in the way of successful aerial navigation. The experiments made by Comandant Renard during the Franco-German War at the instigation of the French Government were reviewed, the object of those experiments being to produce a dirigible balloon. The first balloons used were cigar shaped, but as the experiments progressed it was ascertained that fish-shaped balloons—that was, full fore and slim aft—required less power to drive them. The propelling power for the most part was supplied by electric motors driven by accumulators, which were, unfortunately, so heavy as to make it impossible to carry sufficient power to propel the balloon against even a light wind. Commandant Renard succeeded, however, on several occasions in making short excursions and returning safely to the point of departure, but that was always done in a dead calm. Giffard proposed to make an elongated balloon some thousand feet in length, he being of opinion that with this a speed of twenty miles an hour could be obtained, but the expense and trouble were so great that the project was abandoned.

### BALLOONS AT THE END OF THEIR TETHER.

Count Zeppelin appeared to have had both the pluck and the means necessary to carry out a gigantic experiment of the kind, but even that had not brought the solution of the question any nearer or added to previous knowledge on the subject. It had often been stated that Commandant Renard, so far as navigating the air with balloons was concerned, had reached the end of the tether, but it appeared that he was rather chary about using petroleum motors in the presence of highly inflammable gas. M. Santos-Dumont had gone "one better" than Commandant Renard in that he pluckily took advantage of the new light petroleum motors such as had been developed for the purpose of driving autocars, and by attaching one of these machines to an elongated balloon had succeeded in driving through the air at a pace considerably greater than had ever before been accomplished. This had enabled M. Santos-Dumont to make short excursions and to return to the point of departure even in the face of a slight wind—a feat which had never before been accomplished. The balloon used was as light and strong as it was possible for the best French balloon makers to construct it, and the motor used was the lightest and strongest that modern science could at present devise. It might therefore be concluded that, as far as balloons were concerned, it would not be possible to improve greatly upon what M. Santos-Dumont had achieved. He had advanced the science of ballooning further than it had ever gone before. In fact, he had come very near the boundary line, beyond which it was, to his (Sir Hiram Maxim's) mind, impossible to go. A balloon by its very nature had to be very light and fragile, or it would not rise in the air. Its mean density was less than that of the air it displaced. In other words, it was a mere bubble. If it were possible to make a motor which would develop 100 h.p. for every pound of its weight, it would still be impossible to navigate a balloon—no matter how well made—against even a moderate breeze. It was impossible to make a balloon strong enough to withstand being driven through the air at any considerable speed, and yet at the same time light enough to rise in the air. Therefore balloons must of necessity always be at the mercy of the wind, even though the wind were no stronger than that which prevails at least three hundred days in the year.

### POSSIBILITIES OF THE AEROPLANE.

Those who sought to navigate the air by machines lighter than the air had, he thought, come practically to the end of their tether. They could not hope for any new development which would enable them to do much better than they had already done. The possibilities before them were extremely small. On the other hand, those who sought to navigate the air with machines heavier than air had not even made a start as yet, and the possibilities before them were very great indeed. In all nature they did not find a single balloon. All nature's flying machines were heavier than the air, and depended altogether upon the development of dynamic energy. In nature's machines the amount of energy developed for a given weight was very great indeed, but no greater than the artificial motors which were produced at the present time. It was quite true that a bird could develop a great deal more energy from a pound of carbon consumed than it was possible to develop with any artificial motor, but, on the other hand, nature had not yet developed a bird that could feed on petroleum, and petroleum carried much more energy in proportion to its weight than any food on which it was possible for a bird to feed. Petroleum motors had already been developed which were sufficiently light to propel machines which could fly after the manner of birds, and it would be possible for human beings to fly whenever they could ascertain how this power might be advantageously employed. It was now only a question of time and money. Although the difficulties which had been encountered by the balloonists in order to reduce the science to its present degree of perfection had been very great, the troubles which beset the men who would make a flying machine were still greater. The action of the air appeared to be very erratic, and he proposed to show some of the phenomena that one who conducted experiments with true flying machines might expect.

### SIR HIRAM MAXIM'S "MERRY-GO-ROUND."

His own first experiments were made with what might be called a "merry-go-round." He had a long arm mounted on a pivot which described a circle two hundred feet in circumference. To the end of the arm he attached a cigar-shaped apparatus driven by a screw, and arranged in such a manner that aeroplanes could be attached to it at any angle. The apparatus was provided with various instruments which enabled him to accurately ascertain the thrust of the screw, the power required to drive the screw, the lift of the aeroplane, and the speed in miles per hour. The first aeroplane attached was about four feet long and sixteen inches wide, the underneath side being slightly concave, and both the edges being made sharp, it being understood that the aeroplane was driven sidewise through the air. He first attached it with an inclination of one in fourteen, and fastened to each of the corners strong wires so as to prevent the plane from being deformed by the lifting. Each wire was strong enough to stand about three times the total lift of the aeroplane. When the apparatus was started, and a speed of about forty-five miles per hour had been attained, it was found that the lifting effect was very uneven indeed, due probably to a light wind and eddying currents of air. As a result one of the wires was broken, the aeroplane destroyed, and the broken fragments destroyed the screw. After this he, of course, employed much stronger wires. He found that he could lift and carry at the rate of 133 lbs. per h.p., whilst it was necessary to have a speed of at least forty miles an hour in order to produce good results. A kite, for example, was held up against the wind by the pull of the string, and as the string was at an angle the kite was pulled downwards at the same time. A good kite would mount in the air until it reached an angle where the downward pull of the string was four or five times greater than the pull against the wind. In a flying machine the screw thrust held the machine up against the wind or drove it through the air, which was the same thing, and the weight of the apparatus was the downward pull. Prof. Langley had called the upward pull of a kite or aeroplane the "lift," and the tendency of the machine to travel with the wind the "drift," which, of course, was identical with the screw thrust necessary for driving a machine through the air. He (Sir Hiram Maxim) with his "merry-go-round" was able to produce fourteen times as much lift as drift, but on making an aeroplane one foot wide, slightly concave on the underneath side and sharp at the edges, and then mounting it in a strong blast of air blown through a discharge pipe three feet square at a velocity of forty-two miles an hour, he was able to obtain a lift eighteen times as great as the drift.

### THE GREAT FLYING MACHINE.

In a true flying machine the screw thrust must, of course, be equal to the drift, and it would be an exceedingly simple matter to make a flying machine on the aeroplane system provided it were possible to produce on a large scale the same amount of lift in proportion to the drift as it was possible to produce in a small experimental apparatus. Small aeroplanes were easily made of wood, and the wood was sufficiently stiff to prevent their being deformed by the action of the air. But when their size was increased some lighter material than wood was necessary. In some experiments he made with moderate-sized aeroplanes, consisting of fabric drawn tightly over a wooden frame, he found that he could only carry at the rate of 40 lbs. per h.p. Moreover, size itself was an important factor. Suppose they arranged a dozen aeroplanes, each a foot wide, in the air directly behind each other, it would be found that the forward one lifted a great deal more than the one next to it, whilst the last would lift very little indeed. The first aeroplane was continually striking new air, the inertia of which had not been destroyed, and in order to produce a lifting effect it threw the air downward; consequently, all the aeroplanes which succeeded this were riding on air, the inertia of which had already been disturbed. In other words, the air was travelling downwards, and the lifting effect became greatly reduced. So with large aeroplanes the front edge practically did all the lifting, and the only way to obviate this was to make the aeroplane in the form of a curve, so that the angle was always increasing. This, however, increased the amount of power required. In his large machine, when he ran the engines up to 300 h.p., he had a screw thrust of 2,200 lbs. If he had been able to lift even 10 lbs. to each pound of screw thrust the total lifting effect would have been 22,000 lbs. The aeroplanes were very large, and it was necessary to have an immense number of struts, braces, and wires in order to give them the necessary rigidity and to hold them in position. and all these offered great resistance to being driven at high speed through the air. The result was that with a screw thrust of 2,200 lbs., and a speed of forty-two miles per hour, the lifting effect, instead of being 22,000 lbs. as he had hoped, was only slightly over 10,000 lbs., and as the weight of the machine complete was 7,500 lbs., the margin of lifting effect was not very great, and even this was only obtained by the expenditure of an immense amount of power. Originally, he only intended to employ 100 h.p., but the atmospheric resistance due to the wires and braces was so great that it ultimately amounted to 360 h.p., which required a steam pressure rather more than 300 lbs. to the square inch. The screw propellers were 17ft. 11in. in diameter, each with two blades, the mean thrust of each blade being 550 lbs. The screws were provided with stays to prevent their being bent forward by the thrust. At first he used wires with a margin of safety of four, but these gave way when the engines were only developing about 200 h.p., allowing the screw blades to be bent forward, when they not only destroyed themselves but the greater part of the machine. Ultimately he was obliged to have wires which would hold a load of at least ten times the average strain brought upon them, this being due to the eddying of the wind, which put sudden and unexpected strains upon the screws. His machine was mounted on a steel railway track having a gauge of nine feet, and there was another track having a gauge of thirty-five feet outside and above that with a reversed rail, and the machine was mounted upon springs in such a manner that the lift could be accurately measured. When, however, the lifting effect was sufficient to move the load from the steel track of nine feet gauge another set of wheels came in contact with the inverted track, which prevented the wheels from being lifted completely off the lower track.

### Mishaps.

Sir Hiram Maxim had at first (continued the paper) intended to prevent the machine being lifted off the lower track by using cast iron wheels of very great weight. It appeared that he would then be able to measure the tendency that the machine had to lift off these wheels, which would enable him to place the centre of lifting effect directly over the centre of gravity. However, when running along the track at a speed no greater than thirty-five miles an hour a slight puff of wind caused the machine to lift from the track, wheels and all, and coming down the wheels sank into the soft wet earth. Another slight puff of wind tipped the machine completely over, breaking the framework, and doing damage which cost quite £1,000 to repair. It was only when it was found quite impossible to keep the machine on the track at anything like a moderate speed that he was forced to provide the upper track of 35ft. gauge, and even with this it was impossible to obtain anything like accurate measurements as to lift, except in a dead calm. If the wind were blowing across the track at a velocity of only four miles an hour the lift on the windward side of the machine would become excessive and dangerous, whilst the lift on the leeward side would be correspondingly diminished. In one of his last experiments he tied the machine up to a dynamometer, and ran up the steam pressure until the screw thrust exceeded 2,200 lbs., and then, when the engines were developing this tremendous amount of power, the machine was suddenly detached from the dynamometer and darted forth with a suddenness for which the crew of four men were not quite prepared. Every man who was not holding on to something was thrown down. They soon attained a speed of forty-two miles an hour, when all the wheels were seen to be running on the upper track and revolving in the opposite direction from those on the lower track. After running about a thousand feet one of the axletrees for holding the machine down doubled up. This put the whole lift of the machine on the other three. The upper track was broken, the machine was liberated, and floated in the air, giving those on board the sensation of being in a boat. However, a piece of the broken track caught in one of the screws. At the same instant he shut off the steam, and the machine stopped and settled to the ground, the wheels sinking into the soft turf without leaving any other marks, showing that the machine came directly down and did not run on the grass before coming to a stop.

### PETROLEUM MOTORS AND ALUMINIUM.

In these experiments the wheels that engaged the upper track did not come into contact until the machine had lifted about six inches. The first five inches of lift were employed for working the pencil on two dynagraphs, which furnished a diagram of the lift through the entire length of the road. At the end of the five inches the machine had to lift completely off the lower wheels. By this means not only did he have a diagram showing the exact lift off both the forward and back axletrees, but by painting the wheels before starting he could easily ascertain at what point the machine was actually lifted from the lower track and came in contact with the upper one. These experiments had demonstrated that a machine could be made on a large scale in which the lifting effect was considerably greater than the weight of the machine. At that time the steam engine appeared to be most suitable for the purpose, but since that time great improvements had been made in the direction of extreme lightness in petroleum motors, and he was strongly of opinion that very much better results could be obtained with petroleum motors than he had obtained with a steam engine. Moreover, the quantity of water required with a steam engine was about seven times as great as that required to cool the cylinders of a petroleum motor of the same power. In his first experiments he provided a very light condenser, which on account of being driven through the air at a high velocity was very efficient, so that the weight of metal was only 1 lb. for the water condensed from each horse-power. He was able to condense all the steam when the power did not exceed 100 h.p., but it was quite out of the question with 300 h.p. Consequently the water supply would only last a few minutes. Not only had great improvements been made in motors during the past decade, but aluminium had been greatly improved, so that it could be hardened with from twenty to thirty per cent. of magnesium, which made it quite as light as pure aluminium, and yet as strong as wrought-iron. This put into the hands of the engineer a light and reliable material infinitely better than anything that could be obtained at the time he (Sir Hiram Maxim) conducted his experiments. The amount of room in Baldwyn's Park, where the experiments were made, was insufficient, and he found a great deal of manœuvring would be necessary before he would be able to cast off and launch the machine into the air.

### DIFFICULTIES OVERCOME.

The art of managing a flying machine in the air without practice was like attempting to learn to ride a bicycle without a bicycle, or learning to skate without skates. It was difficult to learn the art of flying without actual practice; and the actual management of a machine in the air, no matter how perfect, would require quite as much skill as was required to ride a bicycle, as well as the nerve and pluck of a Santos-Dumont. He thought it would, therefore, be obvious that those who would navigate the air with machines heavier than the air had a task before them which was worthy of their steel. However, the motive power and the material were to hand, and with skill, pluck, and the necessary funds, as well as plenty of room for manœuvring near the ground, actual flight on true flying machines was not only possible, but practicable, and when such a machine made its appearance, although it might not be profitably employed for carrying passengers or freight, it would yet be of inestimable value to the empire for military purposes. (Loud applause.)

A number of slides illustrating the general appearance and details of construction of Sir Hiram Maxim's machines were shown upon a screen, and were explained by Sir Hiram Maxim himself.

### THE DISCUSSION.

Upon discussion being invited, Mr. Percival Spencer said Sir Hiram Maxim's paper was so lucid that he thought it would help forward immensely the solution of the great question in which they were all interested. They must all agree that one important point that had been given to the world that evening was that Sir Hiram Maxim considered that the steam engine was superseded for aerial navigation purposes by the ordinary motor car oil engine. So that, having this extra means at their command, they had another assurance of being able to navigate the air by means of an aeroplane. Speaking as a balloonist and an aeronaut, he thought the difference which was assumed to exist between the two systems of aerial navigation was really less than was sometimes imagined, and upon consideration it would be found that a line of demarcation did not actually exist between them. While up in a balloon on one occasion, he tried a simple experiment in regard to aeroplanes by taking a piece of paper, doubling up the edges so as to make it float horizontally, and then let it loose as they were going at thirty-five miles an hour. The paper, which was heavier than the air, floated along and kept pace with the balloon, which was a mere bubble lighter than the air. The great difference supposed to exist between the aeroplane and the navigable balloon had been magnified, and need not be considered. What the elongated balloon did was this—it enabled the aeronaut to soar aloft into the air without any motive power, and placing him there so that he could make use of the oil engine, propellers, and steerers, exactly as they should do were they to work with an aeroplane. Everyone must agree that the eventual solution of flying through the air was likely to come, and would be well done by means of the aeroplane. Having these two means before them—the balloon, a perfectly practical instrument by which at any moment they could ascend into the air, and the other the aeroplane, which never carried a human being into the air—let them as aeronauts experiment with the navigable balloon, and eventually come to the navigable aerostat. He entirely agreed with Sir Hiram Maxim that the fish-shaped balloon was better than the cigar-shaped one. Count Zeppelin's experiments, upon which a vast amount of money was expended, had not resulted in the furthering of the subject to the extent that had been hoped, because he was undoubtedly going to work in too large a way without making use of stepping-stones like M. Santos-Dumont, who had taken a very important step in the direction of perfecting aerial navigation. Sir Hiram Maxim had observed that M. Santos-Dumont had possibly attained the greatest result that was ever possible to attain by a navigable balloon. As an aeronaut and a student, he (the speaker) scarcely thought that was so. He had taken the smallest balloon it was possible to use and a 20 h.p. motor. They knew that to take up a very much more powerful motor—one approaching the power that Sir Hiram Maxim had used—would require, not a surface proportionately larger, but a considerably smaller balloon, as far as its surface was concerned, in order to carry the necessary weight. So that he could not help thinking and believing that for some time to come they must persevere with this navigable balloon system before attaining to the heights which they should eventually reach in the Maxim aeroplane system. With regard to the question of going against the wind, he could not help putting before them the fact that they, whether balloonists or flying machinists, knew no wind at all when once in the air, whether they were in a balloon wafted like a bubble, or in a Maxim flying machine, they moved along in an absolutely dead calm. So that, when once in the air and clear of all connections with the earth, they need not be worried with the question of wind. It was only a question of going at a greater and greater speed. Therefore, the atmosphere was for all practical purposes a dead calm, because the balloon was always moving perfectly with it—whether at twenty or fifty miles an hour. The balloon could be propelled through the air; let them hope the aeroplane would be eventually equally satisfactory.

Mr. E. Humphrey Wingfield, referring to the question of surface friction by the air upon a balloon, said that was practically nil. Even on a railway train the side friction was comparatively unimportant, the friction being principally on the end.

### THE REPLY.

Sir Hiram Maxim, in reply, said with regard to the wind—a question which Mr. Spencer had referred to—very few people could get a proper grasp of the conditions that one found on leaving the surface of the earth. No matter at what velocity the wind might be blowing, the fleeciest cloud was not torn asunder, provided it was far enough from the earth. The rolling and tumbling effect of clouds was produced by the motion of air over high buildings, mountains, and trees. Prof. Langley had conducted a series of experiments in Washington to show that the irregular lifting of the air was due to the unevenness of the surface of the earth over which it was passing—just as in a large stream, the water passing over boulders became disturbed and agitated. They should take into consideration the fact that although the air might appear perfectly stationary, yet if a feather or a piece of gold leaf were floated in it, it would keep pace with the balloon from which it was thrown, the balloon or flying machine and its contents being in the wind and travelling with it. The difficulty was to travel against the wind. Suppose the wind was blowing at the rate of forty miles an hour, in order to keep over the same spot the balloon would practically have to be travelling at that rate against the wind. To travel at the rate of sixty miles an hour in the same direction as the wind it would be necessary to have a motor that would carry them at that speed, for until the speed of the motor exceeded that of the air the motor would be of no assistance. Those were the conditions that had to be met by anyone who made a flying machine. They must always consider that the air was moving in relation to the earth, and that they did not wish necessarily to travel with the air, but to leave one part of the earth's surface and get to another part. When he was in France on one occasion he found that the speed of their balloons was a little less than the speed of the air, and they always went along with the wind. (Laughter.) Suppose they made the strongest balloon it was possible to make, and towed it against the wind by a locomotive, the balloon would follow the locomotive, but when it reached a speed of about ten miles an hour the front end of the balloon would be deformed, a pocket being made there, and the instant that pocket was formed it would tear the balloon to pieces. It was impossible to make any balloon to stand a velocity equal to that of the winds which one found to prevail at least three hundred days in the year. In the matter of side friction, his own experiments proved that atmospheric friction might be considered not to exist at all, or at any rate the quantity was so small that it might be neglected altogether.

### "ATMOSPHERIC CURRENTS."

A paper upon the above subject was then contributed by Mr. William Marriott, assistant secretary Royal Meterological Society, and it was illustrated by lantern slides. The matter was treated from a meteorological rather than from an aeronautical point of view. Speaking of clouds, the lecturer said balloonists had never yet reached an altitude where clouds were not seen above them, and the motion of clouds as observed by balloonists was, as a rule, much faster than observations made on *terra firma* would lead one to suppose. He dealt with aerial currents as affecting balloons, and remarked that unexpected disturbance was sometimes experienced by aeronauts owing to cross currents. He trusted that the members of the Aeronautical Society would be able to help the Meteorological Society in regard to meteorological conditions in the higher reaches of the atmosphere. If the Aeronautical Society could help the Meteorological Society in gaining information on the subject of the upper air, they would be delighted. A short discussion followed.

### SCIENTIFIC ASPECTS OF M. SANTOS-DUMONT'S EXPERIMENTS.

The Chairman then asked Mr. Bruce to read a paper on "Navigable Balloons and the Scientific Aspects of M. Santos-Dumont's Experiments." After intimating that he was undertaking this duty as the president's substitute, Mr. Bruce said he thought all present would agree that it was the duty of every scientific society, when examining the details of any new experiment that came within its scope, to search diligently for the truth, and therefore it would seem to be the duty of the oldest aeronautical society in the world to examine carefully the exact conditions under which the experiments of M. Santos-Dumont were made in the endeavour to ascertain what truths they had to teach. An old saying of Tacitus applied equally well to the twentieth century as it did to his day—"Truth is only brought to light by time and reflection; not by haste." He (Mr. Bruce) would, however, bring before them a few scientific facts, and make a few suggestions that might help them in their efforts to discover how exactly the experiments of Santos-Dumont formed a landmark in the history of aerial navigation.

As a preliminary, he reviewed briefly the history of navigable balloons, and illustrated his remarks by photographs upon the screen of notable aeronauts and the machines which they had devised. M. Giffard discarded the ordinary spherical shaped balloon, and adopted one of elongated form. He employed steam for motive power, making a light engine and boiler. The engine worked a screw 12ft. in diameter, and the funnel of the engine was inverted so as to minimise the danger of setting fire to the gas in the balloon. M. Giffard ascended on the 24th Sept., 1852. There was a strong wind blowing at the time, and he never attempted to struggle directly against it. He only made circular movements with lateral deviations. He (Mr. Bruce) had often wondered why, after such elaborate preparations, no further experiment was made. He had been told by a friend of the aeronaut that the real reason was that Giffard was dissatisfied with his boiler, and, simply on account of this did not proceed further with the matter. The brothers Tissandier in 1883 devised a balloon of similar shape in which the motive power was electricity. They stated that they held their own against a wind of nearly three metres a second.

The experiments of Renard in 1885 were noteworthy as being the first attempts in which a direct return journey was made with his balloon "La France." According to the accounts which M. Renard sent in to the French Academy of his experiments, he claimed that out of seven journeys the balloon returned five times to the place whence it started. A map showing the routes of the three trips made by the balloon between Paris and Meudon, on September 22nd, 1885, was shown upon the screen. The journeys, however, were not made to time, but the aeronaut went as he pleased. The question might be asked, whether in 1885 there was anything to prevent such a balloon as "La France" from winning the prize which Santos-Dumont had carried off, had such an inducement been offered at that time? The greatest difficulty would have been the electric battery, which was a troublesome means of providing power in a prolonged series of experiments. In Renard's experiments, the wind force was estimated at from 3 to 3.50 metres a second. Count Zeppelin's great airship, 420ft. long, was shown. This machine ascended on October 21st last year, and was only twenty minutes in the air, but it made a return journey against a wind which did not exceed 3 metres a second. Then, coming to the experiments of M. Santos-Dumont, whose latest type of balloon was shown upon the screen, he said they were considering a very remarkable man. It could certainly be said that he was the first aeronaut in the history of aerial navigation who had steered a balloon from a given point, round a given point, and back to the starting-point, and had kept up to time. There he thought the difference came in between Santos-Dumont and Renard. The latter made a return journey, but not up to time, and Santos-Dumont in doing so, if he had not advanced aeronautics in principle had in practice. (Applause.) There was very much to admire in the personal qualities of Santos-Dumont, for what qualities were dearer to the British heart than pluck, courage, and dogged determination to attain the object sought? All these had been vigorously displayed in Santos-Dumont. The temporary failures which would have crushed and defeated less manly spirits, had been merely instructive stages in airship construction. M. Santos-Dumont had shown originality in his work by the introduction of an inner balloon to maintain the rigidity of the outer envelope; and the fastening of the framework to the balloon by rigid steel wires was a great step in advance. [The lecturer performed an interesting experiment to illustrate the effect of the inner balloon.] Now, in regard to the main point—the wind force actually overcome—had M. Dumont made any advance over his predecessors in this important respect? As a result of enquiries from the courteous secretary of the French Aeronautical Society, who paid a special visit to the Eiffel Tower to ascertain from the observatory there the force of the wind at a height of 305 metres from the ground on the day that M. Santos-Dumont made his ascent and won the Deutsch prize, he learned that at 2.42 p.m., when the balloon left the ground, the wind had a force of 4.5 metres per second. Eleven minutes later, when the balloon rounded the Eiffel Tower, the wind had a force of 6.1 metres. These figures proved that M. Santos-Dumont had made an advance as regarded the overcoming of wind force. The figures only represented a light wind, certainly. These experiments as to the air resistance were of the utmost importance, and experiments should undoubtedly be made on the airship itself. Another point suggested by these considerations was that if there were any further prizes offered for competition under similar circumstances, the wind force should be a condition of the competition. It was well known that a balloon could be successfully navigated on a calm day; now they wanted to try, by experiment, what force of wind could be resisted. What was the exact limit that had been reached? Let that be ascertained by experiment, and let people who offered prizes stipulate that the wind force must not be less than a certain figure. It would be rather difficult to fix where that particular force of wind should be—whether on the ground or in the air—but that it was an important feature was very evident, because at the present time competitors could choose any day they liked. At any rate, they always chose a day when there was a very light wind blowing. He hoped, therefore, that in any future competition the wind force would be a *sine quâ non.* He did not wish to dogmatise upon the point as to whether the balloons would burst, but he would say this—that each competitor taking part in such a competition should be provided with a parachute, and that he should practise himself in the use of such apparatus, so that, if his balloon should burst, he would be provided with a convenient means of leaving his balloon and landing safely on *terra firma.* In concluding these remarks, he would exhort all those at work on this great problem to take to heart one great lesson taught by the efforts of the bold Brazilian aeronaut—never to mind failures, and whenever a failure occurred to look to the cause, and, having found the cause, they would probably find the road to success. Like M. Santos-Dumont, let them work with enthusiasm, for that was the lifeblood of science, as it was of art. In other words, it was earnestness of purpose that was necessary. When in the twilight of imperfect knowledge, they appeared at times to meet with insuperable obstacles, let them apply to their own special work those inspiring words of a living author who was present that evening—"There are realms of knowledge awaiting the human race; kingships awaiting kings. Children of earth, will ye not rise up and fill those thrones, and wear those golden crowns?" (Applause.)

The Chairman remarked that if he were to comment adequately on the interesting papers that had been contributed that evening he should feel sorry for his hearers. Suffice to say that they would all join him in thanking Sir Hiram Maxim, Mr. Marriott, and Mr. Bruce for their able papers. (Applause.)

A vote of thanks to the chairman for presiding closed the proceedings.

### TISSANDIER'S BALLOON.

This navigable balloon (date, 1883), to which Mr. Eric S. Bruce referred in his lecture before the Aeronautical Society on Tuesday, December 3rd, reported above, may be thus described: It was elongated in form, 91ft. long, 29ft. in diameter through the middle, and covered with thin cloth coated with an impermeable varnish. Over the balloon, which was inflated with hydrogen gas, was spread a netting suspending the car by means of twenty ropes. A kind of rigging connected the suspension ropes about 6ft. above the car. To this rigging the guide and anchor ropes were attached, and the rudder, which was made of unvarnished silk, was also arranged behind. The screw propeller, 9ft. 3in. in diameter, consisted of two blades, which were driven by electricity; and the electrical apparatus consisted of a potassium bichromate battery and a dynamo electric motor. The car, with the motor, batteries, screw, anchor, and other fittings, weighed nearly 1,200 lbs. The amount of ballast usually taken up was 850 lbs. in weight, and the balloon itself weighed 600 lbs. In one trial, with the screw making 180 revolutions per minute, Tissandier is said to have been able to keep head to a wind which was moving at the rate of 10ft. per second. When he was proceeding in the same direction as the current, he was able to deviate from the line of wind with great ease.

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Great interest is being taken in the ascents in connection with the Aero Club, another of which is fixed to take place on the 10th inst.

## An Early Pioneer.

It may, perhaps, be of interest to know that a paper was started in France in 1863 called *L'Aeronaute* by a photographer named Nadar, who claimed to have solved the question of flying. He made a balloon called "Le Géant," with which he hoped to obtain sufficient money, by means of exhibitions, ascents, etc., to enable him to carry on his experiments in flying by means of the screw. He referred to this balloon as the last that would be built. Nadar also published a book in England on the subject of aerial flight. An accident to the aeronaut when making his second voyage prevented further experiments.

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## A New Flying Machine.

The Motor Power Co., Ltd., of 14, Regent Street, London, S.W., the makers of the speedy Napier autocars, have now turned their attention to aerial flight, and are prepared to turn out flying machines, which, broadly speaking, will be built on the Santos-Dumont principle. The balloon is 75ft. long by 25ft. greatest diameter, and has a capacity of about 25,000 cubic feet. An air bag is fitted for equalising the pressure. The balloons will be made by Mr. Spencer, and will carry his guarantee of best workmanship and material. The underframe is 50ft. long, and takes the form of a latticed girder. The balloon will be propelled by a four-cylinder Napier water-cooled petrol motor with electric ignition, which is capable of giving not less than 14 h.p. The steering is effected either by a rudder or by altering the direction of the propeller. The price of the machine will be £950 net, about the same as a high-class motor carriage, and the time for delivery is six months.

# Complimentary Banquet to Santos-Dumont.

## THE INTREPID ARIEL NAVIGATOR AT THE METROPOLE.

IT was not to be supposed for a moment that England could suffer the circumnavigator of the Eiffel Tower, and the winner of the prize offered by M. Deutsch for the first man to accomplish such feat in an airship under certain conditions, to be in this country without receiving hospitable recognition of his great feat at the hands of those who have the subject of aerial navigation very close at heart. The banquet offered to the persistently and patiently heroic young Brazilian in the Whitehall Rooms of the Hotel Metropole on Monday evening, Nov. 25th, was, both in its character and the number of men of light and leading who attended it, evidence clear and sufficient of the unprejudiced admiration with which the British public have watched and waited upon each endeavour of the famous Brazilian aeronaut to fulfil the conditions surrounding the acquisition of the Deutsch prize. Seldom have the Whitehall Rooms echoed to such "thunderous" volleys of cheers as greeted the rising and sitting down of M. Santos-Dumont, and the straightforward, manly speech in which the toast of the evening was given by the Chairman. No fitter inauguration of the Aero Club of Great Britain could have been made than the function at which such honour was done to one who deserves so greatly, and whose great feat, as the Earl of Dundonald so happily put it, "marks a milestone in the history of the world." The receipt of the toast and its accordance of musical honours without musical prompting showed how strongly beat the great pulse of that large assembly in the most earnest and most sincere admiration for the slight and modest little man who had so greatly dared, and, daring, accomplished. In the centre of the cross table sat Major-Gen. the Right Hon. the Earl of Dundonald, C.B.M.V.O., having on his right Signor Santos-Dumont, the guest of the evening, and on his left His Excellency the Brazilian Minister, Sr. Joaquim Nabuco. The great cavalry leader was also supported to the right and left by the following gentlemen: The Hon. Charles S. Rolls, the Right Hon. Lord Suffield, K.C.B., Professor Sir William Crookes, F.R.S., Mr. R. W. Wallace, K.C., the Hon. John Scott Montagu, M.P., Mr. Paris Singer, Sir Claude Champion-de-Crespigny, Bart., Major F. C. Trollope, Professor John Perry, F.R.S., Sir James Crichton-Browne, M.D., F.R.S., Sir Vincent Kennett-Barrington, Col. R. E. B. Crompton, R.E., Mr. Mark Mayhew, L.C.C., Mr. Edward G. Frost, Mr. Howard Saunders, F.L.S., Col. Templer, Mr. Frank H. Butler, Mr. Eric Stuart Bruce, Mr. E. B. Knobel, Prof. Sir Norman Lockyer, K.C.B., F.R.S., Signor Cardoso de Oliveira, Signor J. C. Rodrigues, Mons. Chermont, Mons. Emanuel Aimé, Mr. A. M. Singer, Dr. Boverton Redwood, D.Sc., F.R.S.E., Mr. Neptune Blood, and Prof. D. S. Capper, M.I.C.E.; while here and there amidst the numerous company we noticed Dr. J. J. Acworth, Mr. E. Majolier, Mr. H. J. Swindley, Mr. Hugh Weguelin, Mr. J. Steward Mallam, Mr. Harold Perrin, Mr. H. Hewetson, Signor G. Aranha, Mr. Frederick R. Simms, Mr. Wm. J. Leonard, Mr. Henry Edmunds, M.I.C.E., M.I.E.E.,

*Vandyk.* *Photo.*

SIGNOR SANTOS-DUMONT.

Mr. E. Manville, M.I.E.E., Mr. T. W. Staplee Firth, Dr. F. W. H. Hutchinson, Mr. S. H. R. Salmon, Mr. B. Boverton Redwood, Mr. Arthur Paget, Mr. Henry Sturmey, Mr. Robt. E. Phillips, Mr. Lyons Sampson, M.I.M.E., Mr. R. W. Buttemer, Mr. T. B. Browne, Captain Bower, Mr. Spaight, R.E., Mr. Molesworth, R.E., Mr. Harvey, R.E., Mr. E. Campbell Muir, Mr. C. W. Mitchell, Mr. W. G. Smyth, J.P., D.L., Mr. Charles W. Bell, J.P., D.L., Mr. R. B. Bruce, Mr. E. M. C. Instone, Mr. Carl Meyer, Mr. W. J. Pitman, Mr. Harold Crosland, Mr. G. A. Templer, Mr. C. Johnson, Dr. Barton, Mr. W. J. Crampton, Mr. J. Edward Waller, M.I.C.E., Mr. E. Garcke, M.I.E.E., Mr. W. H. Schneider, Mr. Ballin Hinde, Mr. R. Wallace, Mr. Arthur Sharpe, Mr. Samuel R. Roget, Mr. Robert B. Bird, Mr. Claude Crompton, Mr. A. E. Campbell Swinton, M.I.C.E., Mr. C. Jarrott, Mr. S. F. Edge, Mr. Julius Harvey, Mr. J. D. Siddeley, Mr. Foster Pedley, Mr. J. J. Overton, Mr. C. Friswell, Mr. Astell, Mr. F. A. Rodewald, Mr. Harold L. Cosh, Mr. W. M. Hodges, Mr. Arthur O. Stopes, Mr. J. Taylor N. Davies, Mr. E. W. Peall, Mr. Bernard R. Banks, and Mr. F. F. Wellington. Dinner having come to an end, and the loyal toasts having been enthusiastically honoured, the toast of the "Republic of the United States of Brazil" was felicitously given from the chair, and responded to by the Brazilian Minister. His Excellency expressed his pleasure that his great countryman had so happily descended upon English ground. He was sure that the Brazilians who had been so kindly invited, and who were so delighted to be present that evening, would ever bear such an auspicious occasion in mind with a feeling of national pride. No matter what the future of aerial navigation might be, the name of M. Santos-Dumont as the first man to construct a dirigible airship would live in history as the precursor of that age which set itself to the serious scientific solution of the problem. The great French nation had a proverb to the effect that a single swallow did not make a summer, but in the present matter he hoped he might predict that the real conquest of the air had been practically heralded by the solitary swallow they had met to honour. (Cheers.)

"The Naval and Military Forces of the Empire" was next proposed in a neat and telling speech by Mr. Roger Wallace, K.C., who referred generally to the great value which M. Dumont's successful experiments must have in connection with military observation during warlike operations. The toast was responded to by Sir Claude de Crespigny, Bart., for the navy, and Col. Templer, director of military ballooning, for the army. The latter gallant gentleman, as a practical aeronaut, expressed the sincerest admiration for M. Dumont's construction and work.

The Earl of Dundonald then gave the toast of the evening, viz., the "Health of Signor Santos-Dumont," and said that in meeting there to do honour to that gentleman they were at the same time met to celebrate an event of the hugest importance in the history of the world. The world of science recognised no geographical boundaries, and discerned no difference between nationalities, languages, or customs. The man who achieved victory over natural obstacles proved himself a friend of humanity, although they were none the less pleased that their courageous and illustrious guest belonged to a nation with which this country was in intimate and cordial friendship. In the past there had been many who had made a close study of aeronautics, and had striven to steer airships against the wind. Many able minds had endeavoured to achieve the solution of this great problem, but it had been left to their guest of that evening to demonstrate by his late remarkable and daring feats that such solution could be accomplished. He felt sure that Signor Dumont was far too generous a man to grudge honour where honour was due, and that he would certainly recognise the great work of that famous Frenchman M. Henri Giffard, who in 1851 constructed a cigar-shaped airship in which he placed a steam engine of 3 h.p. for the purpose of propelling it, but whose further progress had been baffled by the too great preponderance of weight to horse-power. Also he was certain Signor Dumont would recognise his debt to those eminent automobile engineers whose ingenuity had constructed engines of such light weight that he had been able to obtain a motor suitable to his purpose. The experiments made by Signor Dumont had been so fully described that he would only recall to their minds that he had risked his life on many occasions in carrying them out, and that in one instance nothing intervened between him and death but a single steel wire. After the construction of his fifth airship, and after the accident referred to, he had accepted M. Deutsch's challenge, and had performed the journey of eight miles from St. Cloud to the Tour Eiffel and back, with a wind blowing at a speed of eighteen to twenty miles an hour, and had made the turn round the tower at a radius of forty yards, a thousand feet above the ground. That performance, whatever might come after, would mark a milestone in the history of the world, and they could not but admire him for his success and the indomitable courage he had displayed. Not only those in that room that evening, but the whole British people, would join in the hearty wish that all Signor Dumont's future efforts would be crowned with success, success which he so richly deserved. He could assure him that when other names now prominent in contemporaneous history had long been relegated to oblivion, the name of Santos-Dumont would be honoured and remembered. He gave them health and long life to Signor Santos-Dumont.

The toast was then drunk with the utmost enthusiasm, three of the most earnest and heartiest cheers we have ever heard and one cheer more following the musical honours which spontaneously accompanied the drinking of the toast.

Upon rising to respond Signor Santos-Dumont was accorded a most remarkable reception. The whole company sprang to their feet, and cheering with much waving of serviettes was again renewed. When at last silence was restored the modest little gentleman read his reply as follows in mild low tones, which were somewhat difficult to catch: "I wish to thank you for so kindly conferring on me the title of honorary founder and member of the Aero Club of the United Kingdom. I am for the moment the only member of your club, but I hope I shall not be so for long, as I have the pleasure to meet here this evening a large number of candidates who will soon be elected. If I am proud to see my name at the head of this list it is because I know that the list will be a long one, and will, moreover, be composed of the most honourable names in the scientific and sporting world. (Cheers.) When I return to London in a few months I hope I shall find your young society in full progress. (Cheers.) The sympathetic reception that you have accorded me will encourage me to return next summer, after my aerial voyage from France to Corsica. (Cheers.) I shall then be happy to make some trials in a steerable airship above London, and thus contribute my modest part to the work of a society which will count among its members such distinguished aeronauts as Col. Templer, Mr. Butler, Mr. Charles Rolls, the youngest and at the same time the oldest of your aerial pilots—(laughter)—and such a sportsman as Mr. Wallace, the president of the Automobile Club, and Mr. Paris Singer, one of the first pioneers of automobilism in England." (Cheers.)

In proposing the toast "Success to the Aero Club of the United Kingdom," M. Santos-Dumont said: "In drinking to the health of Lord Dundonald, who does us the honour to preside at this inaugural banquet, I drink to the health and prosperity of the members of the club present, of those who are absent, and especially of Mr. Alfred Harmsworth, who is, unhappily, ill. I also drink to the health of the great British nation, which, after gaining the empire of the seas, already aspires, thanks to your initiative, to the empire of the air." (Cheers.)

The Hon. C. S. Rolls replied. He said the club was at present not a large one, as it possessed at the moment but one member, viz., the gentleman who had just proposed the toast to which he was pleased to respond. A committee had been formed to invite Signor Dumont to become a member and to dine. The idea of forming the club had originated during a balloon trip which he had made in company with Mr. Frank and Miss Butler. It was the proposal of Miss Butler, and no sooner had it been made than the valve cord was pulled and, descending, they took immediate steps to put the lady's suggestion into operation. The candidates, thanks to the co-operation of the A.C.G.B. and I., now numbered close on two hundred, and included such well-known aeronauts as Sir C. W. Pollock, Col. Templer, Major Trollope, and others. When the club was formed these and other gentlemen would be asked tô give the club accounts of their adventures in the upper regions of the air. The sport of ballooning was not attended with danger, as no less than six hundred ascents had been made by the Aero Club of France without a single accident. Trips could be taken per balloon without danger of interference from policeman, although he should hesitate to say that that would always be so. In conclusion, Mr. Rolls reminded the company that this country had been well to the fore in the study and practice of aeronautics, and recalled the names of such men as Coxwell, Glaisher, Spencer, and others. Indeed, at one time England held the lead, and he hoped that the presence of Signor Santos-Dumont with them that evening would encourage them to make an effort to regain it.

"The Visitors" was given by Major Trollope, and replied to in an eloquent and interesting speech by Sir J. Crichton-Browne. Professor Jno. Perry, F.R.S., then proposed the "Health of the Chairman," referring to his grand work in the relief of Ladysmith. In his reply to same the Earl of Dundonald said that no country could afford to disregard the march of science, but that so far as aeronautics went from a military point of view he thought that the country was safe in the hands of Col. Templer.

When on the point of leaving London, on the 28th Nov., Mons. Santos-Dumont wrote to Mr. C. Johnson, the secretary of the Automobile and Aero Clubs as follows: "I thank you and all most sincerely for your sympathetic reception during the past seven days. We leave London this evening, carrying with us most pleasant memories. Pray convey this message to the members of the Automobile Club and of the Aero Club, whom we have met in London. Yours, with all cordiality, SANTOS-DUMONT."

# An Uproarious Meeting.

AT the November meeting the feeling which has been running so high between the opposing camps in France as to the merit of M. Santos-Dumont's performances found vent even in the deliberations of the Société des Ingénieurs Civils de France, which, probably for the first time in its history, became so uproarious that it was impossible to follow the discussion. M. Armengaud, jeune, delivered an address upon the trials of M. Santos-Dumont, and sought to prove that the Brazilian aeronaut had made real progress in aerial navigation. The well-known aeronautical engineer, M. Surcouf, and others insisted that there was an entire absence of data to show that M. Santos-Dumont had made any notable advance. The trials had not been carried out on scientific lines. While he had succeeded in steering his balloon and driving it at a certain speed, there was absolutely nothing to prove that he had done better than his predecessors. Major Paul Renard, one of the directors of the Meudon military balloon station, was of the same opinion, and urged that in view of his considerably increased power, M. Santos-Dumont had not improved upon "La France" of twenty years ago. The supporters and opponents of the Brazilian aeronaut tried to argue out the matter all at once to such effect that the meeting broke up in confusion, and the conference did not appear to throw the slightest light upon the much-vexed question as to whether M. Santos-Dumont has made any real progress in the science of aerial navigation by his successful and unprecedented feat.

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## Up to Date.

Messrs. De Dion-Bouton and Co., who are well known in the automobile trade, are taking up the question of motors for balloons. They have been experimenting with motors of 25 h.p. for this purpose, but they are now making a new motor developing 40 h.p., which will weigh only 400 lbs. This possesses four cylinders in line with a single aluminium crank chamber. Seeing the interest which is now being taken in motor balloons, this motor should have a considerable sale, as the weight is very low considering the horse-power developed, and the reputation of Messrs. De Dion-Bouton and Co. is a guarantee that the workmanship will be of the very best. The firm will be pleased to furnish further particulars to anyone interested in the subject.

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# Flying.

## The Record of Aerial Navigation.

WITH WHICH ARE INCORPORATED

**The Flyer, The Flying Machine, The Aerostat, The Aeronaut.**

No. 2. QUARTERLY. MARCH, 1902.

# Motor Aviation of To-day and of Recent Years.

By SIDNEY H. HOLLANDS.

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(*Continued from page 18.*)

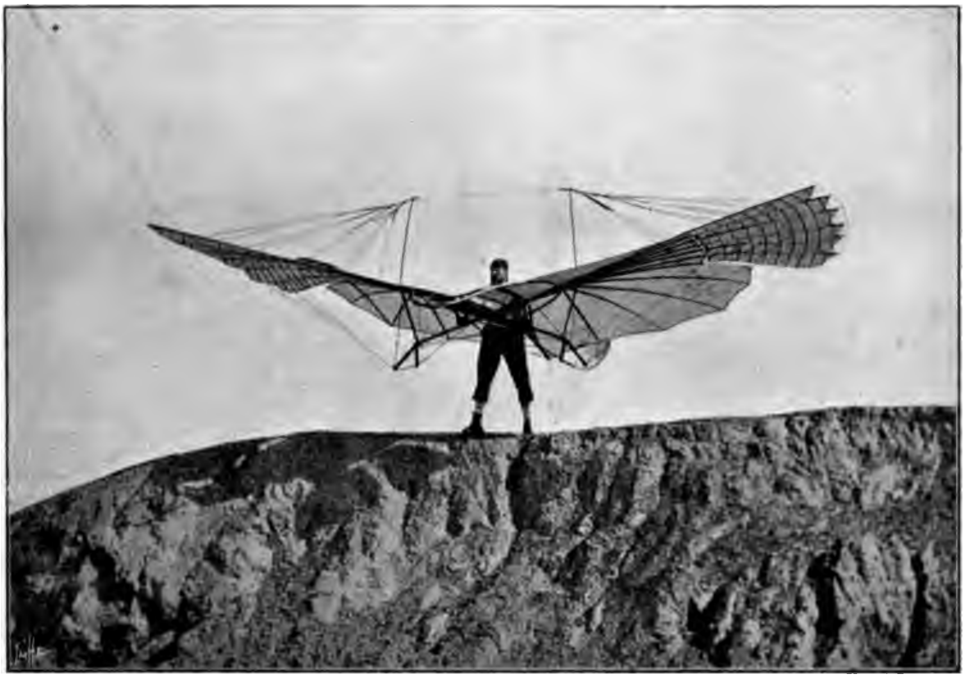
### AERIAL SAILING OR PASSIVE MAN FLIGHT.

REVERTING to the notion of man's flight by his unaided muscular energy (but only to emphasise the fallacy of such attempts to those not yet convinced), some characteristically dry remarks of Sir Hiram (then Mr.) Maxim on the subject are worth repetition. That gentleman once said at a meeting of the British Aeronautical Society: "I wonder if any of us have ever thought how a man would look if he had his (pectoral) muscles sufficiently developed to be able to exert sufficient power to perform flight with his own unaided efforts? I find that his lungs would have to weigh 40 lbs. in order to absorb the necessary amount of oxygen, that the muscles on his breast—provided he did the work with his arms—would have to weigh 75 lbs., and that his breastbone would have to extend forward 21in." (similarly to a bird's "keel," and for the same purpose) "to form a strut or support to which these muscles would have to be attached. Now, supposing his weight should not be increased over and above what it is now, I find that his legs would have to be reduced to the size of a broom handle, his feet to mere claws, and his head cut down to the size of an apple. Such men do not exist at the present time."

Mr. Lancaster, of Chicago, also in a facetious vein apparently (with a suspicion of the Hibernian Sir Boyle Roche about it), said: "If a man were a butterfly, bug, beetle, or small bird, weighing a few ounces, he would have a good time of it, but his hundred pounds (and more) avoirdupois effectually bars the way to any possibility of *active* flight *derived from his physical exertions*." (The italics are the writer's.)

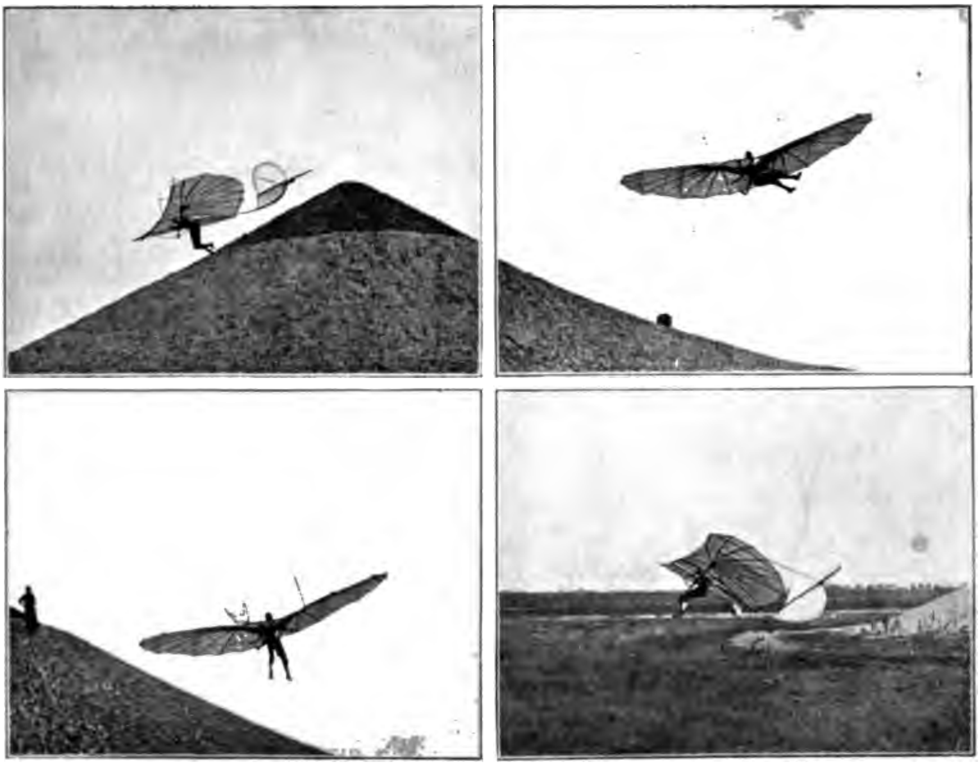
It may be remarked here that the very interesting trials and experiments of the late Dr. Lilienthal were not attempts at man flight, that is, as popularly understood, but were of a semi-parachutic, semi-sailing nature. In fact, he was, in his own way, following the course advocated by Mr. Lancaster as long ago as the year 1882, whose rational views and beliefs are entirely adverse to "man flight," as indicated in his opinion quoted in the preceding paragraph.

Dr. Lilienthal essayed to "emulate the gliding kite" by endeavouring to employ the natural forces as the great sailing birds do, and his very instructive experiences may well be quoted here. In an exceedingly interesting article entitled "Weshalb ist es so schwierig das Fliegen zu erfinden?" (Why is it so difficult to learn to fly?) which appeared in a Berlin journal *(Prometheus)* shortly before his lamented decease, he says: "Whether the imitation of natural flight is one way of many or the only way is to-day (1894) still matter of discussion. . . The mercilessness of the wind towards all flying machines is a new difficulty in their invention. With me the wind has often enough played 'catch-ball,' when, in my sail practice, I was surprised by gusts of wind in the middle of my course. I was suddenly lifted house high and thrown hither and thither in such a way that, before I became accustomed to it, I lost my breath. In this one may become an air-gymnast in the boldest meaning of the word, and I believe I am entitled to an opinion on the effect of the wind on free flying machines and the reason of its destructive action. Herr Anschütz, on the 14th September last (1894), took some 'snap shots'" (which are reproduced) "of my practice in windy weather. These show what tricks are necessary, moving the legs about, etc., to shift the centre of gravity as required in order to keep one's seat, and to bring the machine unharmed to *terra firma*. If we did not actually see birds flying with ease and battling with the wind we should despair of flight. What is the prospect of our flying? What are our aims in aviation? Up to what pitch of perfection will it be possible to bring aviation? There is an impossibility of (truly) predicting to what pitch of perfection flying may be brought, because hitherto the practical exercise has been so little worked at. When here and there an idea for a flying machine is executed and comes to grief this is of little importance to aviation in general. Generally, flying is theorised upon only, and this is of little use to the present state of affairs. Development—evolution is the right word—must pioneer us in aviation. We are well up in the theory of flight to-day, since we are enlightened as to the air resistance of the bird's wing and *the power-saving quality of its profile curve*. We are able to picture to ourselves all the phenomena of natural flight. The difficulties to be eliminated are of a purely practical nature, but they are greater than at first appears. They should be made a special study of, and we should invent methods to investigate them in order to successfully overcome them. The method which is to lead to practical flight must be capable of development be its beginnings ever so primitive, and by it we must be afforded an opportunity of really skimming through the air, by which we may gain experience as to the stability of flight, the action of the wind, and safe landing, in order—by continual development—to gradually approach permanent free flight. Perfection cannot be forced immediately. It is because inventors require too much from their constructions that the positive results are so little. Remaining in the air without a balloon and free flight in it form such a new sphere of action that it is necessary to *gradually* find one's bearings in it. Whoever loses sight of healthy development by continually increased experience will never attain anything in this sphere. The means proposed and put into practice by myself, viz., beginning with small flights and going on increasing them, are known to my readers. After finding that flights can be stably and safely effected from high points even with simple apparatus and even in semi-strong winds, in order to get into the soaring so much admired in birds it was necessary to try them in stronger winds, and also to assist simple flight (sailing) by dynamic means in order to go gradually into permanent flight *in still air*. For this it was necessary to have a suitable starting point, and this the author has made for himself by making an artificial conical mound fifteen metres high; a run is taken to the edge. At the moment of landing the sail surface is tilted up in front to check the forward velocity. An apparatus with beating wings (for rowing flight) has also been practically tried. The distance across wing points is eight metres. A motor run by compressed carbonic acid produces the beats. Except for the feather-like wings, this apparatus is similar to the ordinary sailing surfaces, and the pressure of a finger (on a valve) controls the beats (see illustrations). For the rest the handling of the apparatus is the same as in my ordinary sailing surfaces, and yet the first few cautious trials proved that if I had at once begun with jumping into the air with beats the apparatus would probably not then have arrived undestroyed. There are always new phenomena arising, and a single unlucky landing suffices to ruin the whole apparatus. The thing is not to expect too much at once. I had therefore to be content to make ordinary sail-flights with this larger and heavier apparatus—which, with 40 kilos. (88 lbs.), weighs double as much--in order to practise safe landing, and not until now, when this step has been successfully taken, shall I begin the beats in free flight. There may be other methods of correctly de-



**LILIENTHAL MACHINE, with Compressed Carbonic Acid Motor.**

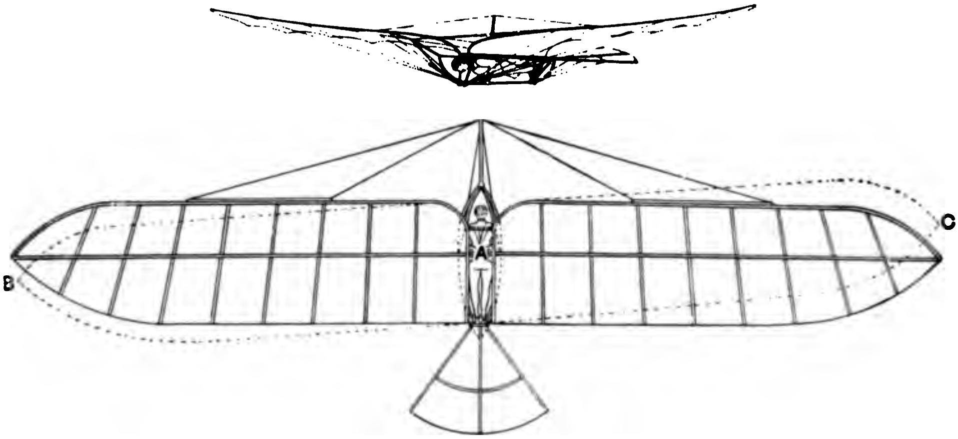
veloping free flight, but they will have the same problems to solve. Thus, for instance, great energy is brought to bear to find a mechanical regulation of the path of flight to the landing, so that the stability of flight is not dependent upon dexterity and practice of the flier. It is very much to be wished that this step should succeed, as it would greatly simplify the problem. Whichever method is pursued progress can only be hoped for when the experiments facilitate an instructive observation of a really free flying body, for here there are entirely new phenomena not met with in other technical spheres."



THE LATE HERR LILIENTHAL'S AIR-SAILING EXPERIMENTS.

In a communication to the British Aeronautical Society in 1882 Mr. Lancaster first states the two following propositions: "(1.) Sailing birds can maintain themselves on rigid wings for any length of time in the air either in a calm or a moving condition of the atmosphere, and translate themselves at will either with or against the current or obliquely to it or either up or down. (2.) They do this without fatigue. They travel with great velocity through the air with no more effort than sitting on a chair requires of a man, or perching on a tree demands of a bird."

Having premised thus, Mr. Lancaster indicates "the way to success" as follows: "To obtain skilful control of any description of surface which could maintain a man's weight in the air might be supposed to demand at least as much skill and experience as to properly use a pair of skates or to ride a bicycle. It is to be expected therefore that many trials and changes must be gone through with by the first successful experimenter before the proper mechanical appliances are discovered, and I will indicate the course to be pursued which, in my judgment, will give the best results. I should use bamboo of the finest quality, putting it together after the manner of the best fishing rods, and should take a buzzard or a crane for a model to work by. The case to contain the person, corresponding to the body of the bird, and the surfaces on each side, say for 6ft., should be made rigid without joint or movable part. From this case to the extremity of the wings would be located the appliances to control direction and rate of speed. *The normal status of all the parts should be the position of maximum results.* The apparatus should be constructed so that the person could lie prone, face downwards, in a nice-fitting case, well upholstered, and with his hands grasping handles controlling the devices for changing or for maintaining direction, so that very small impulses of moving air could be felt. The feet should control the movements of the tail by elevating or depressing it *if it should be found that such a surface was required.* I estimate that 200 (square) feet of surface would be ample to maintain 300 lbs. in the atmosphere. The first new idea the operator would be likely to get would be concerning the tremendous energy there was in moving air. He would have no fear from that time that the weight was going to seriously interfere with his success, and he would probably find that he was constructing his wing (or sustaining) surfaces in too weak a manner."



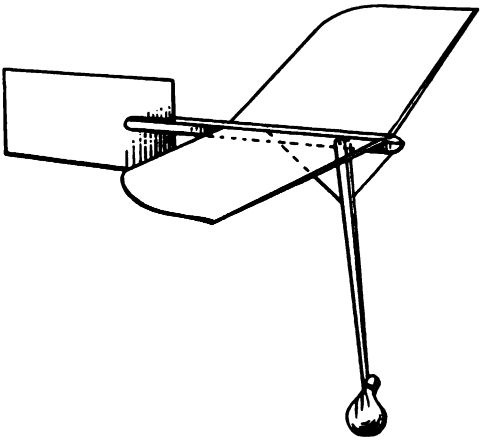
**Herr Gustav Koch's Soaring Flight Machine (Munich, 1889). Steering is effected by the operator slightly shifting the wings to the dotted positions shown by means of the rods he is grasping.**

**A The pivot of the wings. B Position of wings when starting. C Position of wings when alighting.**

After this Mr. Lancaster goes on to significantly remark: "The flight of a bird on fixed wings in a dead calm does seem to invade the great law of conservation of energy."

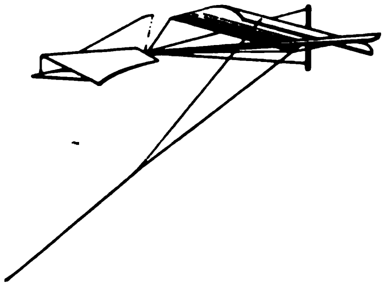
Further on he says: "For a short time I was perplexed at what seemed the necessity of either doubting the fact of such flight or of the validity of such a law. The latter alternative was not possible, and to doubt the former was to discredit my senses in a very violent manner, which I could in no wise do."

Dr. Lilienthal's apparatus weighed about 25 lbs., and had 160 square feet of surface, thus giving nearly a square foot of surface per pound of total weight, the fabric being manipulated by cords and pulleys (but not for propulsion).



Lancaster's "Sailing Effigy."

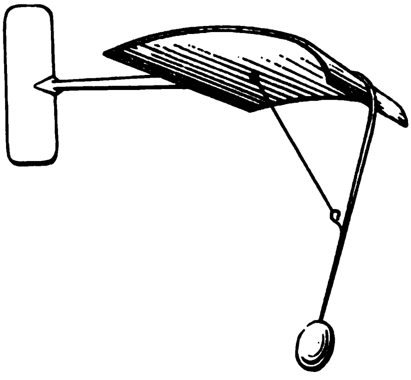
It was admitted that as designed its "flight" would only last as long as the initial impulse (obtained by the preliminary run of the operator), and its transit was, therefore, brief, but why may not such apparatus be endowed with the "aspirating" quality, enabling it to perform true *passive* man flight?



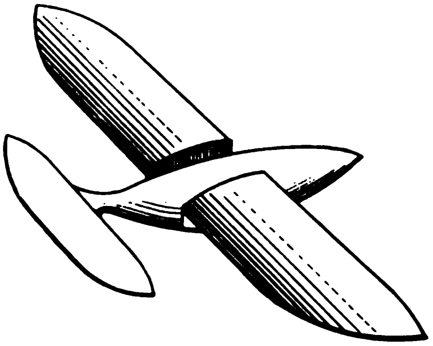
Chanute and Herring's "Aspirating" Kite.

That excellent authority on aviation in general (and "aspiration" in particular), Mr Octave Chanute, of Chicago, has happily defined the latter startling phenomenon, so little known to "the man in the street," as "the act of flying in the face of the wind without using other power than that furnished by the wind itself."

Now, this is not "perpetual motion." It does not contravene the all-pervading law of "the conservation of energy" or any other physical law. It is an act performed by numerous birds habitually (if that which is passive may be termed an "act"), and has been successfully imitated artificially in the aspirating models of Messrs. Hargrave, Chanute and Herring, Lamson, and Carl von Steiger (see illustrations), and will eventually be imitated on the larger scale necessary for the passive flight of man.



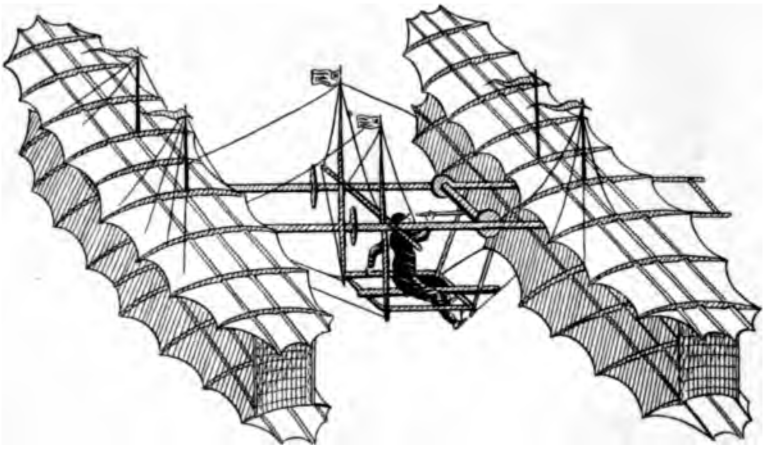
Hargrave's "Aspirating" Model.



Carl Steiger's "Sailing Effigy" (1891).

The "gliding" machine of Mr. Chanute (see illustrations), it will be noted, differs very widely from that of Dr Lilienthal, and yet is at least equally efficient. It has sustained Messrs. Chanute and Herring (separately) in numerous prolonged and graceful air-borne “glides.”

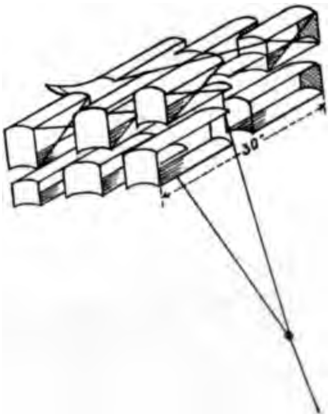
Mr. Chanute once remarked (referring to himself and his assistant, Mr. Herring): “We are working to secure a machine which will be as steady in the air as a boat on the water. When I have developed an air-ship with this quality, then I shall endeavour to fit it with a machine to propel it. Most inventors in this line have sought to find a machine (motor) before having a ship to sail it in.”



**Lamson's latest and successful “Airship.” (Superposed aerocurves in pairs. Soaring flight only; no motor.)**

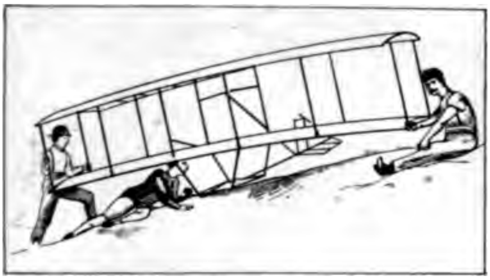
The little multi-aerocurve machine (see illustration) which Mr. Chanute has flown as a kite has shown extraordinary efficiency. While having only a total width of 30in. and a total aerocurve surface of 8¾ square feet, it has lifted a total weight of 54 lbs. (including its own weight of 4 lbs.) in a wind of thirty-five miles per hour. Conversely, of course, if propelled horizontally by a motor at that speed it would give the same lift or sustentation. Mr. Chanute has happily hit upon an excellent and efficient method of preparing the aerocurve sustaining surfaces, rendering them water-proof (an important quality), air-proof, and, at the same time, imparting remarkable stiffness. The latter is another important advantage in aerocurve construction, as any deformation of the surface or departure from the true form of curve and right degree of concavity of underside at once greatly impairs its efficiency.

This valuable process consists in treating the covering fabric (silk) with a thick coating of gun-cotton solution or celluloid, giving the finished aerocurves the con-

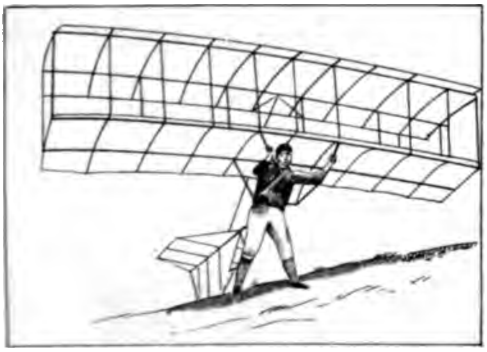


**Chanute's Multi-aerocurve Box Kite, which exerted a total lift of 54 lbs. in a wind of 35 miles per hour.**

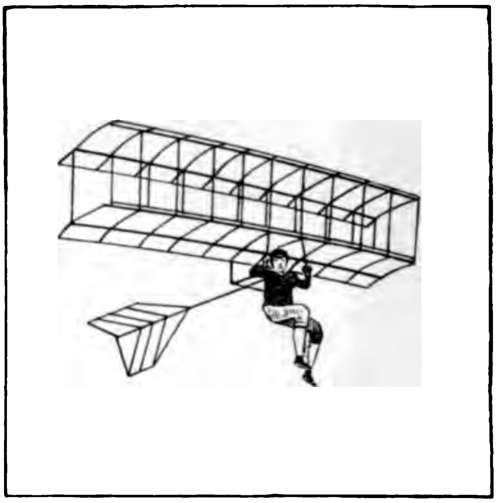
sistency of thin sheets of horn, with all its lightness and stiffness. This article must not close without due recognition of the valuable course of experiment entered upon by the late Mr. Percy S. Pilcher (1896-9). Mr. Pilcher was an earnest disciple, and, to some extent, an imitator of the late Dr. Lilienthal, and, before unhappily becoming also a martyr to the cause, made a great number of successful and admirable demonstrations of gliding flight and of the capabilities of soaring machines. These experiments were witnessed with the deepest interest by numerous spectators.



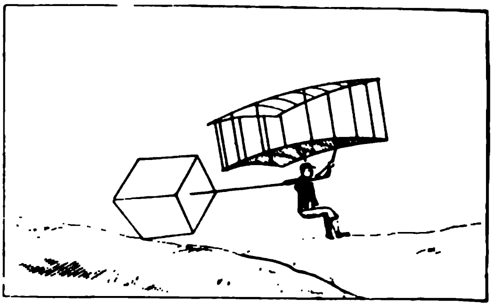
Chanute's Gliding Machine (getting ready).



Chanute's Gliding Machine (poised).



Chanute's Glidin Machine (off).



Chanute's Gliding Machine (stopping).

Mr Pilcher's principal departure from the Lilienthal precedent consisted in starting from level ground (instead of down a hillside), running ahead, and being aided by a tow line (kite like), which was afterwards cast off when the machine was fairly air-borne and under way.

Mr. Pilcher has left us some valuable practical data—for instance, he measured the horizontal pull (or resistance) on his machine necessary to maintain it in continuous forward motion when air-borne and carrying him. He found it to average 25 lbs. at an average speed of twenty-five miles per hour, which pull, as the total weight was 200 lbs., amounted to only one-eighth of the lift. A suitable motor therefore, giving 25 lbs. thrust of propeller, would maintain the machine in continuous flight. The area of surface (concave) was 170 square feet; weight of machine 50 lbs.

Mr. Pilcher intended fitting a 4 h.p. oil motor to this machine. An apposite and memorable remark of his may be quoted to close: "I look upon it as a mistake to make anything bigger than one can possibly help, because the weight and expense, the danger and everything else seem to me to increase with the increase in size."

*(To be continued.)*

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# Balloon Ascent from Paris in a Snowstorm.

### DECEMBER 19TH, 1901.

### By FRANK H. BUTLER.

GAZING from our bedroom windows at the Elysée Palace Hotel that wintry morning, the sky looked very heavy and the general aspect of the weather unpropitious. The Count de la Vaulx, vice-president of the Aéro Club of France, our pilot (who made the record journey for distance in a balloon from Paris to Kief, in Russia, and tried to cross the Mediterranean lately, but, owing to adverse winds, landed off the coast of Spain on a French man-of-war), Colonel Templer (the head of the balloon section at Aldershot), Mrs. Templer, Hon. C. S. Rolls, my daughter Vera, and myself were to meet in the hall of the hotel at 9 a.m. Ordering our lunch from the *maitre d'hôtel*, consisting of fowl and tongue and a box of chocolates, we engaged two *fiacres*, and started for the gas works at Laundy. After a good shake up in a Parisian cab over very bad *pavé*, we arrived, to discover our balloon, "Aéro No. IV.," belonging to the Aéro Club of France, of which our party are members, and M. Mallet, the maker and caretaker of the balloons, ready to receive us. It was now snowing hard in Paris, but to get up above the clouds of snow to a blue sky, borne by the long shape and graceful form filled to its utmost with gas, inviting us to soar, was too tempting to postpone the journey. By 10 a.m. we were all aboard, lunch and all, taking up six bags of ballast. "*Lachez tous*," the Count gave orders, and we floated upwards, bidding adieu to Colonel Templer and Mrs. Templer, who kindly came to see us off as we rose. It was a pretty scene to see the snowflakes fall as we ascended. We passed over Paris, admiring the well-laid-out gardens and open spaces, the people standing at the corners and looking up; we passed over the Seine, with the balloon throwing its curious shadow on the water as it crossed the river; and the Monument of Victory et Puteaux, with its long Avenue de Neuilly. The Eiffel Tower began to fade into the clouds, and we were getting hungry. In the middle of lunch we heard the bugles sounding, and, looking over the edge of the car, found we were over the celebrated Mont Valerien, which played an important part in the Franco-German war, and is strongly fortified. We could see the guns quite plainly, and the soldiers drilling, and thought if we descended inside we should have been taken prisoners, being English. As it was too light to do any harm in falling, we threw a small wing bone into the fort, as a souvenir. Passing over the forests at Versailles, we were close enough to the villagers to ask "*Où sommes nous?*" as even with maps and compasses it is puzzling to discover just where you are, as everything presents a curious sameness from a height, the landscape looking as though the tiny fields were dotted about with the cardboard houses of children.

Ladling out more ballast, up we went again, and soon the foaming clouds began to form a rolling sea below, and for two hours we lost sight of the earth, and seemed to sit on the snow clouds with a blue sky above, the faithful statoscope and barometer showing us exactly the height at which we were travelling. In this infinite silence we felt quite beyond the reach of a police summons for furious motoring, and as though the whole universe and space were ours.

The numerous changes of cloud effects all round were so magnificent that Mr. Rolls, having borne aloft with him a penny whistle, treated us to the tunes of England and Scotland and the enchanting airs of the London halls. These produced a curious echo. As it was near the shortest day, and time was needed to pack up the balloon before dark, we had to descend; although having yet four bags more of ballast, we could have remained perhaps twelve hours more in the air. Slowly we came down, and at last penetrated the clouds, over which we had floated so long in the pure sunshine, to find it still snowing, and once more saw the woods and country below, all clad in a garment of white. Putting all our paraphernalia away in case of a bump, we trailed along the top of the trees and over the woods, much to the astonishment of the rabbits and a fox in a corner. At last we descried two men, and shouted to them "*Attrapez la corde,*" but the wind was taking us too rapidly for the men to run on the snow-clad fields and seize and hold the guide rope. Seeing an open space, "bang, bang, bang" went the *soupape*, and with the three blows of the valve the grapnel was thrown out and held in a ditch, and the balloon resting quietly and gently, rebounding from one small tree to another on the top of a hedge, till the villagers arrived and towed us into the open field.

We descended at the château of the Duchess d'Uzes at Limours, and after packing up the balloon drove in a cart about six miles to the railway station, and returned to Paris.

Thus my daughter was the first lady in the Aéro Club of the United Kingdom to make an ascent, and also the first English lady to make an ascent as a member of the Aéro Club of France. She also has the honour of being the first English lady to drive a Panhard motor car from London to Paris and back in 1900, and to obtain a certificate for driving a motor car in France.

## An Aerial Destroyer.

It has been gravely announced from St. Louis, U.S., that a Mr. Franklin Cameron, of Brooklyn, is desirous of showing off an aerial coast defence cruiser built of aluminium and steel, and weighing nearly twenty tons. It is claimed by the inventor (Jules Verne is *not* a collaborateur) that his airship, which will have accommodation for a crew of eight men, could destroy any navy in the world at a distance of one hundred miles. How, we are not told.

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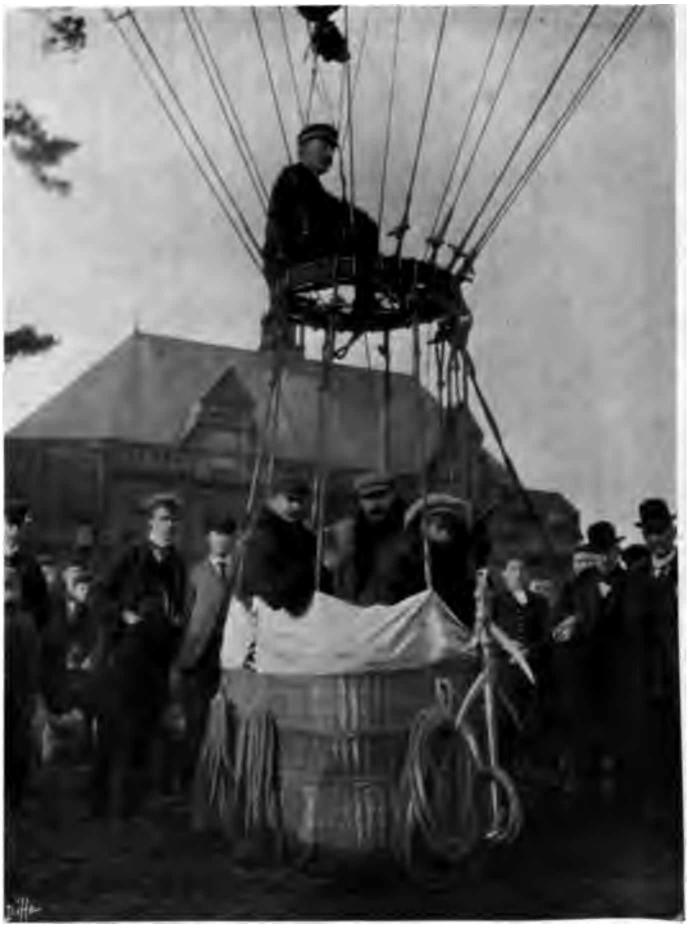
Mrs. Rice, a lady gymnast, is the first woman to soar through space hundreds of feet above the earth, tied to the base of an enormous kite. Several trips have been made by this lady, who, attired as a boy, stands in a small basket suspended from the kite.

# Ballooning.

### By PERCIVAL SPENCER.

By *land* let them travel as many as list,
  And by *sea* those who like the hard fare,
In an airy balloon I will sit at my ease,
  And pleasantly glide through the *air*.

THUS wrote a popular poet in the year 1784, at the time of the introduction of this new means of locomotion. Ballooning was to revolutionise travel on this terrestrial sphere, if not to enable earth dwellers to voyage to the moon and planets. Too much has been expected from the new science, and so imbued has the scientific mind been with these visionary possibilities that disappointment is naturally very general amongst those who expect the aerostat to become at least an active opponent to the locomotive engine. But this is not its province. The poet was right as to the pleasure of balloon travelling; it is the easiest means of transit that can be conceived, but he was wrong when he wrote the next words. The balloon does not "glide through the air"—it floats with the currents. It enables us to move from one part of the earth's surface to another at the speed of the wind wafted onward, sometimes at terrific rates, yet always tranquilly floating in the vast sea of the atmosphere, moving with it, yet apparently without motion. We may even proceed in any direction we like if we are prepared to wait for the wind, but after a hundred years and more we are even yet only on the threshold of the discovery of a practical navigable aerostat. The balloon in its present form offers the only means by which mankind can soar aloft into the air in which it lives and breathes. A trip in a balloon



About to make a few trial ascents.

constructed on scientific lines, and with all the improved appliances which experience has shown to be requisite and desirable, may be taken with every assurance of safety, and with the certainty of givin·· the voyagers an experience the delights of which are known to few, and which never leaves those who have experienced it without a desire to repeat their experiment. The photographs accompanying this article show such a trip undertaken in January, and again repeated in February, by Mr. Leslie Bucknall, of steamship and motor car fame. This up-to-date sportsman has organised a series of such voyages, and, accompanied by friends, as well as an experienced aeronaut, proposes to add the recreations of ballooning to that of yachting and motoring, in which he is already an adept.

**The Balloon Party: Messrs. Stanley Spencer, Leslie Bucknall, James Dixon, and Percival Spencer.**

January and February [illegible] strike the onlooker as seasons when aeronautics can be indulged in with any degree of pleasantness, on account of the imagined intensity of the cold, but this is a popular delusion. Experience shows that cold is felt more severely on the ground than when tranquilly floating with the air in a balloon. Moreover, one often pierces the cold clouds beneath, and feels the direct rays of the sun, which renders the use of warm clothing unnecessary, and that which was desirable on the ground becomes useless aloft, so that overcoats are—as they were in the present ascent— taken off, and it is perhaps more important to avoid becoming sunburnt than to fear cold.

The meteorologists point out that the average speed of the wind is less in the winter months than in the summer, and, as absence of excessive wind is the great desideratum for ballooning, it follows that the winter months are not a bad time, especially when one is able to select a suitable day of fine weather, clear air, and moderate breeze. Such a day is desirable at any time of the year, be it spring, summer, autumn, or winter.

Our illustrations show the balloon inflated in the grounds of Knole Paddock, Sevenoaks, where a goodly crowd of interested spectators assembled to witness the start. Some trial trips were made, and when all ready to ascend, a photograph was taken with Mr. Bucknall and his daughter in the car together with Mr. James Dixon. Mr. Stanley Spencer, the aeronaut, will be observed on the hoop. The day was fair, and so moderate the breeze that there was no difficulty with these manœuvres. The little girl left the car, and the writer took her place to act as historian and photographer on this occasion. The voyage proved as interesting as the start portended, and a circuitous course was taken over the Weald of Kent. Sometimes a mile high, sometimes on the ground, for several hours. After crossing the Medway *en route* for Maidstone, the balloon was permitted to land at Five Oak Green, and, being left in charge of the villagers, the erstwhile aeronautical party adjourned to a neighbouring inn for a light luncheon, and for the despatch of a few telegrams at the local post office. Upon ascending again, the course of the balloon changed, the currents of air being now north-easterly, instead of north-westerly, as previously, and the large town of Tunbridge Wells was viewed from aloft as the balloon passed directly over it. The shades of night alone decided the termination of the voyage. As darkness closed in, the balloon was permitted to land at Eridge, and, being shortly emptied of its gas, was folded up and carried into the railway station for the return by more prosaic means to its starting point.

Ascending from Knole Paddock, Sevenoaks.

**Beginning to Soar.**

# The Aeronautical Institute and Club.

THE second general meeting was held during February at the Society of Arts, Adelphi, W.C., the chair being taken at 8 p.m. by Mr. C. H. M. A. Alderson. The minutes of the meeting held at the same address on 19th December were read and confirmed. The provisional rules were then read and adopted with certain amendments made in the interests of members desirous of obtaining the institute's assistance in the perfection of their designs. Mr. Hugh Middleton being chiefly instrumental in effecting the alterations, and ably seconded by Mr. R. McNair.

The election of officers and committee for 1902 was then proceeded with, the following gentlemen accepting office: Vice-presidents: P. L. Senecal, founder (Chelsea), and H. Middleton (Brighton). Committee: C. H. M. A. Alderson (Farnborough, Kent), Lewis Wells (Broadwell, London), E. C. Dwyer (London), Aug. Le Gaudron (London), R. McNair (London), and Ed. Mote (London). Honorary secretaries: H. E. Holtorp (editorial) and O. C. Field (general), 20, Adelaide Road, London, S.E.

At the conclusion of the meeting the Chairman made a few remarks dealing with the scope of the society and the frequent meetings which were called for by the rules. The institute had been formed with the intention of initiating an exhaustive research into all matters in any way connected with aeronautics, and with a view of giving publicity and financial aid to inventors, who should be members or associates, and whose designs might warrant such encouragement.

# Santos-Dumont Interviewed.

FOR some time past this little aerial hero has taken up his abode among us, the chief object of his visit being to confer with the Aero Club as to the manner and method in which he shall conduct his aerial travels in this country.

With an idea of gaining some definite information on the subject, we called upon M. Santos-Dumont at the Carlton Hotel, Pall Mall.

Fate was kind to us in this matter, for we were lucky enough not only to find M. Santos-Dumont at his hotel, but also Mr. Roger Wallace, K.C., of the Aero Club, who was at the moment taking counsel with him as to his London plans.

Conversation presented no difficulty whatsoever, for M. Santos-Dumont speaks English quite fluently. As he was educated in part at Brighton this is not surprising.

"We presume there is no doubt that you will afford the English public some opportunity of seeing you experiment with your machine before long?" we asked.

"Certainly," was the reply. "That is why I am with you, but at present I have no actual arrangements made."

"But you were at the Crystal Palace yesterday?" we queried.

"Oh, yes, just to discuss matters and inspect the ground available for my airship."

"You think it suitable?"

"Yes, certainly."

"Well, M. Dumont, when will you make your first trip in English air?"

"That I cannot tell you, as nothing is at the moment definitely settled. I am practically in the hands of the English Aero Club. but it is probable that I shall make my ascents from the Crystal Palace."

"Will you build a new airship here for the purpose?"

"Oh, no, I shall use my No. 6 at first, and later on, when it is completed, my No. 7. There is no radical difference between these two ships, except that No. 7 will be the largest vessel I have yet built, for she is double the size of No. 6, although practically the same in design and detail throughout."

"You are billed in certain of the dailies to circumnavigate St. Paul's amidst other things, M. Dumont. Is that so?"

"Really, as I have already told you, I have nothing definitely settled, but matters may all be arranged in a few days."

We then made some enquiries as to the effect of the immersion in the Mediterranean, as M. Dumont was certainly looking extremely well—much better, in fact, than when the Aero Club entertained him at the Metropole Hotel last November.

"Oh," returned M. Dumont, "the papers made a great deal too much of that little *contretemps*. There was no danger—no real danger either to my life or my health."

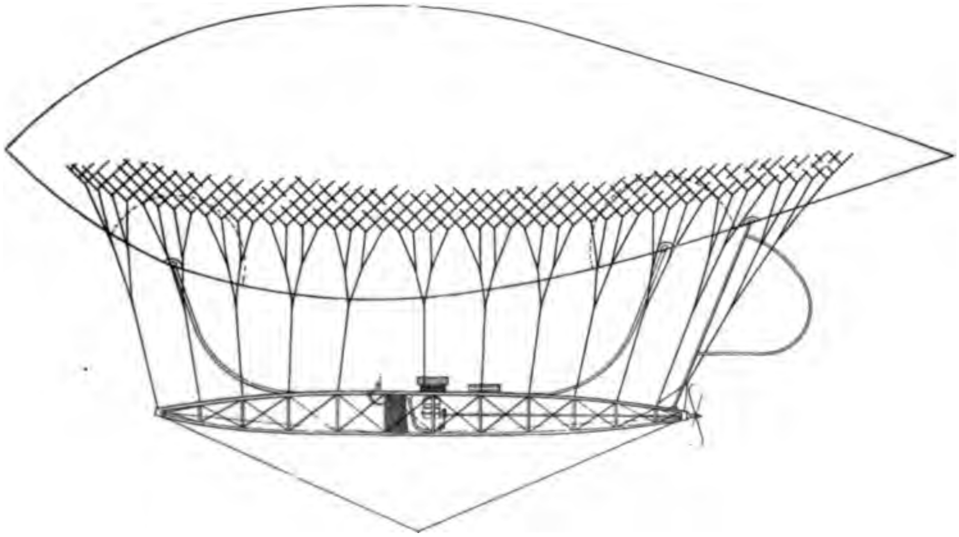
As several gentlemen had already been announced to the Brazilian hero, we wound up our cursory interrogation by a request for an expression of opinion on the future of aeronautics.

M. Dumont replied that his faith in the ultimate success, nay, popularisation, of air travel was unbounded, but said he, "We are only at the beginning of all these things. There is much yet to learn, and to learn only by experience. We shall know more this time next year, and so on as experiments multiply. The whole matter is now being taken up seriously, and there are other workers than myself in the field."

# Professor Hargrave.

MR. LAWRENCE HARGRAVE, whose portrait appears in our frontispiece, is a colonial resident (of Sydney, N.S.W.), although he is a native of London. Like Prof. Langley, he has untiringly devoted about sixteen years of his life to a struggle with the aeronautical problem, to the systematic prosecution of rational experiment, and to numerous contributions to the literature of the subject practically considered; also, like Prof. Langley, Mr. Hargrave has attained a highly encouraging and laudable degree of success with numerous working models, but of smaller size, having used steam, compressed air, and rubber-tension motors, which have performed free flights of several hundred feet. To complete the parallel, Mr. Hargrave is now assiduously at work on a large practical steam aviator of multi-superposed-aerocurve type, in which he hopes to shortly make experimental free flights over Sydney Harbour. Mr. Lawrence Hargrave is in every way a worthy contemporary of Prof. Langley, whose portrait we gave in our first issue.

THE NAPIER AIRSHIP.



Particulars of this machine appeared in No. 1 of "Flying."

# The Use of Balloons in War.

ON Wednesday, February 19th, an interesting paper was read before the Society of Arts, Adelphi, by Mr. Eric H. Stuart Bruce, M.A., General Sir G. W. A. Higginson being in the chair. There was a large attendance of members, and the interest of the lecture was enhanced by the exhibition of experimental balloons and limelight views of balloons being tried at home and in South Africa.

### A HISTORICAL SKETCH.

Mr. Bruce began with a short history of balloons from 1773, when Montgolfier and Charles the Parisian first filled paper bags with heated air and gas. Ten years later the French Government made use of them for taking observations in war, and this was found so successful that when Guyton de Merveau suggested that they might be put to greater use, the idea was at once taken up, and a school of ballooning was started at Meudon. The French made considerable progress in the use of balloons during the latter part of the eighteenth century, but from that time till the war in South Africa comparatively little use of them was made. It may be wondered why maritime ballooning has not been further developed and used for purposes besides reconnoitring. But the lecturer said this was chiefly due to the fact that practical ballooning is still in its early career, and as recently as 1885-86 there was so much scepticism as to its utility that fears were entertained by some as to the ultimate position of the balloon in the British army. The enthusiasm of Sir Andrew Clarke, however, saved the situation, and a balloon factory was erected at Aldershot.

### THE VALUE OF GOLD-BEATER'S SKIN.

Perhaps the strongest point in our national balloon equipment is the material from which the balloon is made—namely, gold-beater's skin. Its advantages over varnished silk are fourfold. It retains the gas much longer, for there is no varnish which is nearly so successful in holding the subtle hydrogen. Secondly, it does not heat and get sticky, which is one of the great faults of varnished materials. A third, but all-important, advantage of gold-beater's skin is its extreme lightness, it being necessary to have, for reconnaissance work a balloon of only a little more than half the size if made of the latter material. At the same time, the reduction in the weight and bulk of the balloon equipment is great, it only being necessary to carry about half the number of steel tubes of gas. A last advantage of gold-beater's skin is its strength, layer upon layer of the thin material being combined.

### AT THE FRONT.

The balloons used in South Africa have proved invaluable, the success of the naval guns at Ladysmith being largely due to messages telegraphed from the observer in the balloon. While the aerial target attracted much of the enemy's fire, this fire did but little harm, partly because it is very difficult to hit a balloon high up and also because, unless hit in the upper part, little damage is done, the upward pressure of the hydrogen keeping it in the air.

Captain Phillips's balloon section accomplished magnificent work with General Buller at Colenso and up the Tugela River. At Spion Kop it discovered that our army was marching into a death trap. Captain

Jones's section went up with Lord Methuen on Modder River, and, in the opinion of experts, there was not a single day on which its observations were not of the highest importance. Lord Kitchener also used balloons, and at Pretoria they rendered the highest service, locating the whole position, and giving the enemy no chance of escape. But it is to Major Blake's section that the honour of one of the most brilliant exploits of the campaign falls. By working for thirteen days continuously with one inflation they prevented the Boers from relieving Fourteen Streams. This was the best test of the efficiency of the retentive power of gold-beater's skin possible.

The translucency of the atmosphere in South Africa was very favourable for taking observations, making it possible to see ten or twelve miles there, where it would only be possible to see seven or eight in England. On the other hand, the strong and often gusty winds were difficult to combat.

### THE ADVANTAGE OF BALLOONS FOR SIGNALLING.

Another great use for balloons in war is that of signalling. The balloons are lighted by means of electric lights inside the balloon, while the operator and most of the apparatus remains on the ground, thus abolishing the necessity for a car, and making a much smaller balloon possible. The Morse or other code can be used for signalling.

Free balloons also might be largely used in war—indeed, during the siege of Paris a regular balloon postal service was instituted, but until they could be steered against winds of some strength they would not be of any very considerable account. The lecturer said he thought it likely that an international convention would prohibit the discharge of explosives from aerial vessels. He then briefly mentioned the fish-shaped balloon of Captains Krebs and Renard, in which electricity was the motive power; the vast airship of Count Zeppelin, which created so much sensation a few years ago, and the last wonderful experiments of M. Santos-Dumont, which combated a wind of about four and a half to five metres a second.

In conclusion, Mr. Bruce said that the work would have to be taken up more seriously, and not looked upon in the light of a sensational sport. He thought that the time had now arrived for the endowment of aeronautical research.

### THE DISCUSSION.

A short discussion then followed, in which Mr. Spencer, General Eardley Wilmot, and Major Trollope took part. The general opinion seemed to be that balloons were invaluable, and that their use would increase. Mr. Spencer said that the chief objection to gold-beater's skin was the expense, inasmuch as though it was thirty-three and one-third per cent. lighter, it cost three times as much. General Eardley-Wilmot read a letter from himself to the *Standard* of twenty years ago, in which he pointed out how much disaster might have been avoided on the Indian frontier if balloons had been used for reconnoitring purposes.

Major F. C. Trollope, superintendent of balloon factories at Aldershot, gave a graphic account of the way the balloons were used at Ladysmith. He said that there had been thirty balloons used in South Africa, but most had returned now.

The lecture was then concluded with a vote of thanks to Mr. Bruce for his able and interesting paper.

# The English Aero Club.

## MR. FRANK BUTLER INTERVIEWED.

TO have some knowledge of the present position and future prospects and intentions of the English Aero Club, nothing is better than to have recourse to Mr. Frank Butler, who may be considered as standing thereto *in loco parentis*, for he certainly had much, if not the most, to do with bringing it into existence, and is at the present moment one of the, if not the, keenest of its members. It will be remembered that at the dinner given to M. Santos Dumont last year it was announced that the English Aero Club existed, but existed in the person of that intrepid aerial navigator alone, and it was chiefly with a view of learning how far the club had issued from its one-man phase that we sought Mr. Frank Butler in his Regent Street fastness, and plied him with questions upon the subject. Our reception by Mr. Butler was most kindly; we found him only too delighted to afford us all the information in his power. The embodiment of the English Aero Club in the person of one gentleman, and that gentleman a Brazilian subject, had always struck us as a curious condition of things, and so soon as we were comfortably settled for our chat, we opened fire upon our genial victim.

"*Does* the Aero Club still consist of M. Santos Dumont, and M. Santos Dumont alone?" we asked.

"Oh, no," was the reply, "M. Santos Dumont was our first, and for a time our only, member, but to-day the club numbers some three hundred, and includes nearly everyone of note in this country who takes a keen interest in the conquest of the air."

"That is good progress, Mr. Butler," we returned, "but you might give us some idea of the constitution and objects of the club."

"Well, you see," said Mr. Butler, "the primary idea in forming the Aero Club was, and is, to maintain it as an amateur association—a body formed of those who take up the study and practice of aerial navigation chiefly as an amusement and a relaxation. We desire to exclude as much as possible any trade or professional element, so that the club may not offer opportunities for the exploitation of any speculative matters. The club, for one thing, will take opportunities of arranging for and organising cross-Channel balloon trips. Indeed, the idea will be to make long journeys in the air, rather than to ascend to very high altitudes."

"But do not trips of this kind come somewhat expensive?"

"No so much as is generally supposed," replied Mr. Butler. "Some very absurd ideas are afloat as to the cost of these things, particularly with regard to the apparatus. Moreover, in the past, in this country at least, folks have been prevented from taking up aeronautics by the appalling fees they have been asked when desirous of making a trip. But it will be one of the chief objects of the club to alter this, in the interests of its members at least."

' How?"

"Well, the club will own its own balloons, and a balloon is not so terribly expensive. It is cheaper by far than a good autocar. You may have an excellent cotton balloon, fully equipped to take the air capable of accommodating four passengers for from £140 to £160. Then the price of the gas to inflate this is about £6, while, with matters arranged as I hope the Aero Club will arrange them, the cost of setting up and filling should not exceed fifteen shillings. Thus four members of the club could arrange to take a most enjoyable trip together in the air at a very reasonable cost."

"But for this some establishment—some kind of balloon garage—with all the necessary appliances, would be necessary," we returned. "Does the club contemplate establishing such a place?"

"Oh, certainly; negotiations with Dr. Hastings, of the Ranelagh Club, are already in hand, and it is in the grounds of the Ranelagh Club that I hope to see the Hangar and the charging station of the Aero Club."

(For the benefit of the novice we may point out that a Hangar is a balloon or airship shed.)

"I hope we shall have there our own hydrogen making plant, for a process has lately been perfected in France by which hydrogen can be made at almost the cost of coal gas."

"You will have some town quarters, of course?"

"Yes, the Aero Club will have its own rooms in the Automobile Club's new premises in Piccadilly, where I hope we shall be very comfortable."

"Do you think many of your members will run the risk of ascents?"

Mr. Butler chuckled and waved his hands in deprecation. "Risk, my dear sir, there is no risk! Nothing could be safer, and, what is more, there are no infernal policemen up there to hold up their hands, and issue summonses and romance before magistrates. The tyranny of the police is the only bitter in the cup of automobilism. Thank heaven, there are no police *up there*."

Our suggestion as to danger seemed to amuse Mr. Butler, for he returned to the charge. "It's safe enough," he stated. "Why, no less than 250 ascents, raising 540 people, were made by the French Aéro Club last year without a mishap of any kind."

"But will not the conduct of airships form the club's objective rather than free ballooning?"

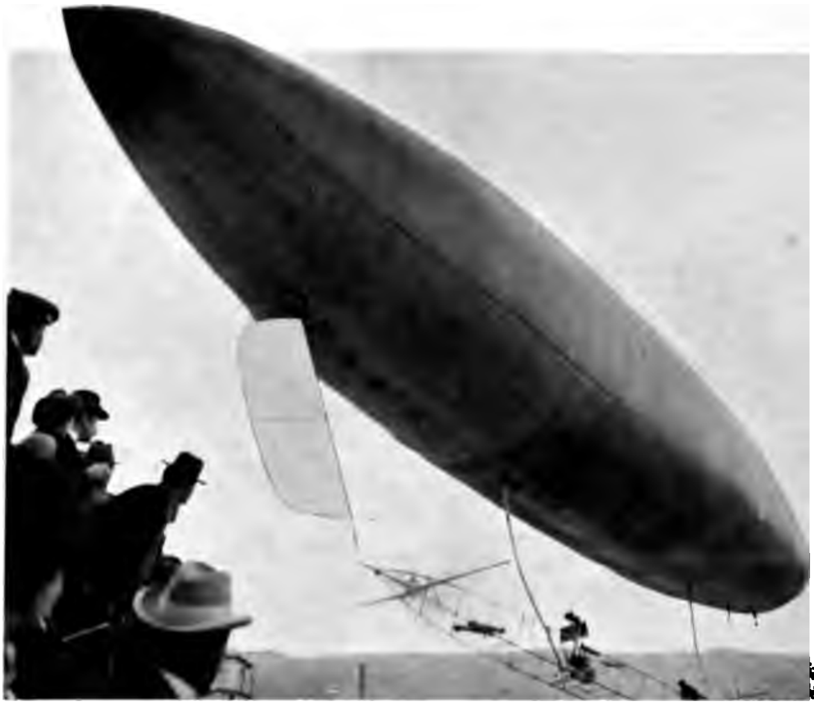
"Free ballooning," returned Mr. Butler, "is the stepping stone; everyone who desires to tackle the question must begin by free ballooning, must learn to be comfortable in, and how to handle, a free balloon. The club will offer prizes for long-distance journeys in balloons, and other important prizes for dirigible balloons or airships. £20,000 is an offer for an airship by the Aéro Club of France and £40,000 in America. It is bound to come."

Just then Mr. Butler was summoned to discuss his new 8 h.p. Renault autocar, and, as we had already detained him over a period which would have caused a less genial and kindly man to murmur, we assured him that we wished the newly-formed Aero Club every success, and departed.

## Coronation Balloon Race.

An old-fashioned fair, which will swallow up forty acres of ground, is to be one of the classic novelties during Coronation times in the vicinity of London. The starting of the Royal procession on the Coronation Day will be announced from the fair by a balloon race, the winning balloon being promised a gold medal worth £100, while other medals valued at £50 and £20 will be awarded to those balloons which may be placed.

# M. Santos Dumont at Monte Carlo.



Making a start.

AFTER showing on several occasions that his balloon was perfectly navigable and under complete control in ordinary weather, and finally proving its qualities by carrying off the Henry Deutsch prize, it was hoped that M. Santos-Dumont had terminated his preliminary series of experiments, and would give some idea of the practical uses to which the balloon could be put during his stay on the shores of the Mediterranean. These further trials were therefore looked forward to with considerable interest, and the arrival of the aeronaut was regarded as an event in the Principality of Monaco. He was the guest of the Duc de Dino, and the expenses of the shed, which was constructed on the shore of the bay, were borne by the Prince of Monaco, but M. Santos-Dumont would accept no financial assistance, though it was offered to him in many ways, notably by a number of English and American enterprising firms, who wanted to bear the cost of inflating the balloon if the aeronaut would allow conspicuous advertisements to be fixed upon it. M. Santos-Dumont had intended taking his No. 7 balloon to Monte Carlo, but, unfortunately, it was not ready in time, and, even supposing that the new balloon had been available, its large dimensions would not have allowed of its safely landing on the shore where the shed was built. He had therefore to content himself with the No. 6 balloon, which won the Henry

Deutsch prize. The object of M. Santos-Dumont in continuing his experiments down South was to undertake long journeys under more favourable meteorological conditions than those usually prevailing in the North, and finally to see whether he could open up aerial communication between Corsica and the mainland, while there was a certain advantage in navigating over the sea, since he could use his guide rope for steadying the balloon, and would be followed by steam yachts in case of accident.

Passing over the Tir aux Pigeons.

No event has probably ever attracted so much interest in the Principality as the experiments of M. Santos-Dumont. The hotels were full of visitors waiting for the day when the navigable balloon would rise in the air, and the hotel-keepers were constantly at the heels of the Brazilian aeronaut to know when a start would be made. On the morning of January 28th the balloon left the shed, and in splendid weather, with a very light wind, sailed twice round the bay. The balloon was remarkably steady, and was kept at a height of about thirty-five feet by the guide rope dragging in the sea. Owing to the awkward situation of the shed there was a great deal of difficulty in getting the balloon back, and more than once it was in danger of being split open during the manœuvres. In the afternoon he made another journey over the bay in the presence of a big crowd of spectators, and remained in the air for forty minutes, first driving round the bay and then going out seawards, where the steam yacht was unable to keep up with him. The balloon was navigated in all directions, and returned to the shed, when again the rudder ran the risk of breaking against the quay. The Governor of Monaco, on seeing the difficulty of landing with the balloon, gave orders for the construction of a jetty to the shed, and the work was immediately started upon. From the Governor downwards everyone took an enthusiastic interest in the proceedings. After a third successful journey the aeronaut decided upon going farther afield, and on February 12th started for Cape Martin, a distance of a little more than two miles from Monte Carlo. The weather was cloudy, and a light wind was blowing dead against him, but, nevertheless, the balloon sailed at a rapid rate, and soon left the yacht of the Prince of Monaco far behind. He was now entirely alone, and there would have been little chance of his getting prompt assistance in the event of the balloon falling into the sea. On nearing Cape Martin the aeronaut turned and got back to Monte Carlo without the slightest incident, though, as usual, the balloon was somewhat roughly handled during the difficult task of landing. M. Santos-Dumont was very warmly congratulated on the success of his run, which was the longest and best he had undertaken since the trial for the Henry Deutsch prize.

On February 14th the experiments came to an abrupt conclusion through another of those accidents with which M. Santos-Dumont has become familiar, though as every accident teaches him something he regards them as necessary stepping stones to success, and he is too much of a philosopher to bemoan a failure from which he is able to derive experience. He had accepted an invitation to visit his friends at the pigeon shooting grounds, which lie a little way outside the bay. Things did not go very well at the start, for he had a good deal of trouble with the motor, and on this working properly he left the shed, when he had an impression that the balloon was not navigating so well as usual. Nevertheless, it made fair progress to the mouth of the bay, when the sun coming out caused

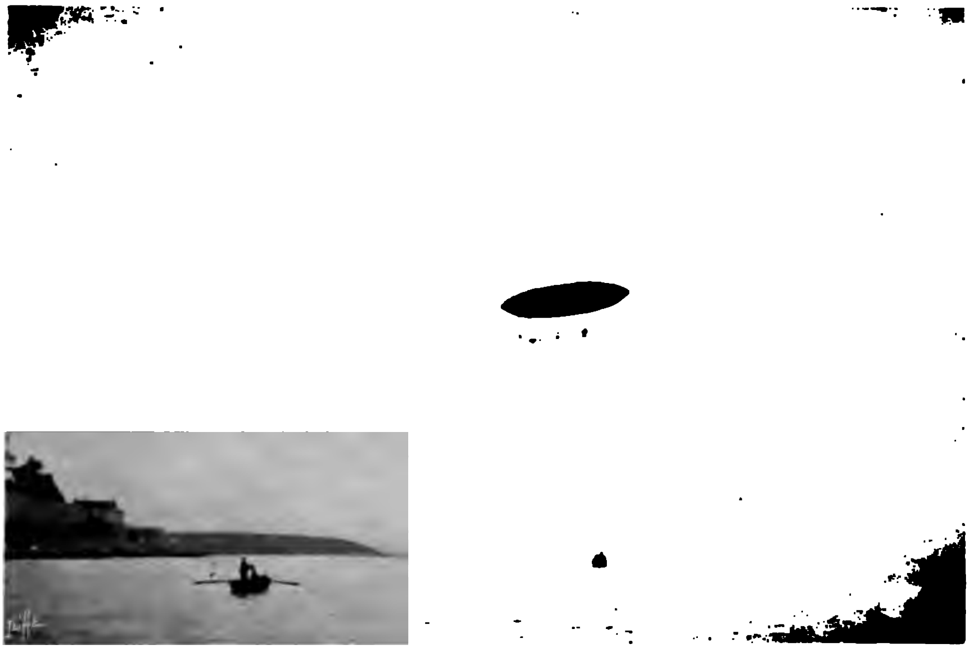
Tacking.

a rapid expansion of gas, and the balloon pointed up at a sharp angle. The wires attaching the keel in front accordingly stretched, while those behind sagged, and the rudder got perilously near to the propeller. M. Santos-Dumont was now in a very critical position. As the guide rope left the water under the influence of the expansion of gas, the stability of the balloon was lost, and, inclining at such a sharp angle, it was in a very few seconds driven up by the motor, whilst almost at the same time the rudder got mixed up with the propeller and wires, and was torn to pieces. The aeronaut stopped the motor, and the balloon was slowly driven back by the wind into the bay. The displacement of gas caused considerable pressure in the front of the balloon, but an explosion was avoided by the escape of hydrogen from the valves, though the rear of the balloon rapidly lost its form, and the aerostat sank like a limp piece of fabric to the water. The rear of the balloon and the back part of the keel were already in the sea, with M. Santos-Dumont himself half submerged, when the boats were able to reach him just in time to extricate him from this dangerous position, and ropes were then attached to the keel so as to draw the wreck to land. At this moment the balloon exploded, and the keel sank to the bottom. Owing to the entanglement of the broken keel, the wires, and the silk envelope, it was a matter of great difficulty to raise it from the bottom of the bay, and it was not until two hours after the accident that the wreck was recovered, M. Santos-Dumont himself superintending the operations from the yacht, despite the fact that he was wet through. The accident created a great impression in the Principality, where the aeronaut had made himself extremely popular by his plucky performances, and general

A view of the machine from below.

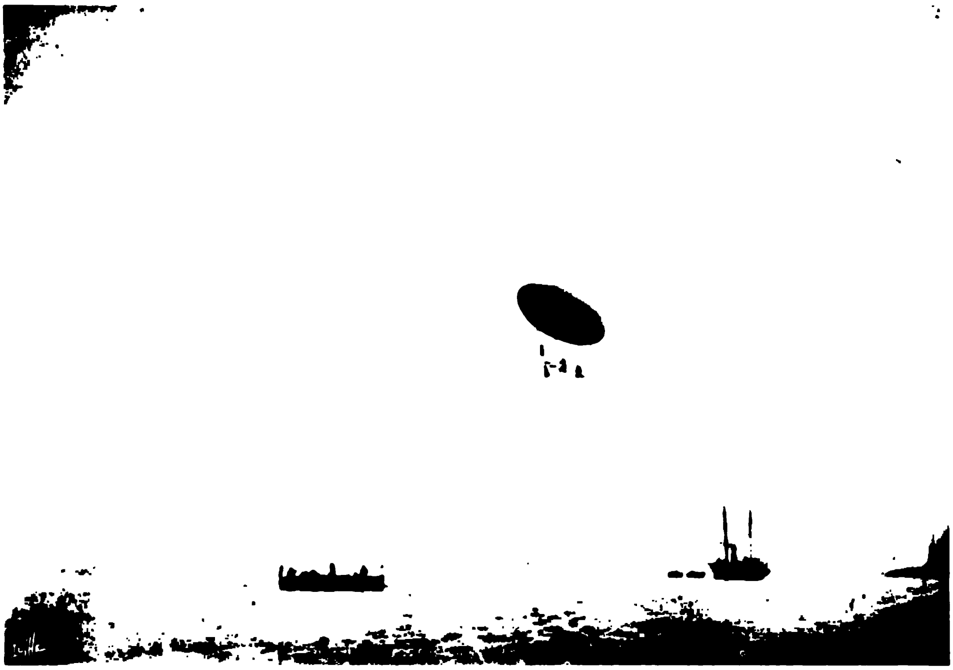
sympathy was expressed with him in his misfortune.

M. Santos-Dumont, however, is not a man to suffer discouragement. On the following day he was indisposed by a chill, but as soon as he was on his feet he returned to the shed, examining the balloon to see whether it could be utilised again. It was in such a deplorable state that the only thing which could be turned to account was the motor, and the aeronaut decided that he had no alternative but to push on with the construction of the No. 7. Immediately after the accident the Duc de Dino called a meeting, and suggested that a subscription should be opened in the Principality to cover the cost of further experiments, and funds immediately flowed in to such an extent that in a very few days as much as 9,000 francs had been raised. Among the largest subscribers were the Duc de Dino, Madame Melba, M. Henri Rochefort, and Mr. Harmsworth. M. Santos-Dumont, however, would not accept the money for fear that his action would be misunderstood, and he withdrew the list from Smith's Bank. At the same time, M. Henri Rochefort, who has been a frequent visitor to the shed at Monte Carlo, and on one occasion even found himself in presence of the Empress Eugenie, has made an appeal to the journalists of Brazil to open a subscription in aid of their compatriot, and it is understood from M. Santos-Dumont himself that he will feel no reluctance in accepting funds from his native country.



**Out at sea.**

It is not likely that M. Santos-Dumont will resume his experiments at Monte Carlo this year. He has sent his No. 6 balloon to London, where it will be exhibited as an interesting relic, and he himself has arrived in the Metropolis, and will possibly pay a flying visit to New York, though he does not know at present what will be his future projects. He has not even yet decided whether he will continue his experiments with the No. 7 or have another built of intermediate dimensions between the Nos. 6 and 7, as he thinks that the latter is too big, and the new balloon is to have certain improvements which have been suggested by his trials at Monte Carlo. The No. 7 has a length of forty-nine metres and a largest diameter of seven metres, and cubes 1,260 metres. The keel has a length of thirty metres. It will have two propellers of five metres diameter, one at each end of the keel, and turning in opposite directions. The propelling mechanism consists of two Buchet motors, developing together 40 h.p., and weighing 160 kilos. The aerostat will have a double envelope of silk, and will be divided into three compartments, so as to avoid any displacement of gas, such as that which resulted in the destruction of the No. 6 at Monte Carlo. It is also intended to give further longitudinal stability to the balloon by having an air balloon in each of the end compartments, so that by filling or exhausting one or the other it will be an easy matter to ensure an equilibrium. Owing to the difficulties that M. Santos-Dumont has had with the Aéro Club de France it is probable that he will not continue his experiments in Paris, though at one time he was credited with the intention of building a shed of his own near the balloon grounds at St. Cloud, but he has accepted an invitation from London to take part in the balloon events which will be held during the forthcoming Coronation festivities. It is probable, therefore, that the trials with his new navigable balloon will take place in England. He will also participate in the com-



The last tack.

petitions of navigable balloons at Trouville this year, if they are held, and also at the exhibition at St. Louis, in the United States, if he finds that it is convenient to undertake the journey. He deserves complete success, and we hope he will attain it.

View of the cage.

# Scientific Observations at High Altitudes.

THIS was the title of a very interesting paper recently read by the Rev. J. M. Bacon at the Society of Arts. As the title suggests, the celebrated aeronaut dealt mainly with experiments made in mid-air in a balloon. Amongst other things, he discussed some noteworthy phenomena which have presented themselves with respect to upper currents met with up to a height not exceeding two miles. Such an observer was Mr. Glaisher, and he speaks with astonishment of the manner in which his balloon on one occasion crossed the Thames, then re-crossed it, moving in an entirely opposite direction, till near the earth it again resumed its former course. The reverend gentleman then cited experiences of his own, one of which he considered probably without a parallel in English annals. The balloon had by mischance passed out of control, and for ten hours he was drifting at a height between 4,000ft. and 9,000ft. above a universal cloud stratum (consequently losing all bearings), his start having been from Newbury, and his final descent taking place near the coast of Neath, Glamorganshire, where the wind was blowing half a gale. In this voyage he must have been either blown out to sea and brought home again, or else for the first sixty miles the wind at this high altitude could only have been blowing at a rate of less than eight miles an hour. Differences in the drifts of upper currents and quick transitions from one drift to another are among some of the most noteworthy experiences of balloon voyages. Proceeding, the lecturer stated that not unfrequently it is possible to determine that the course of horizontal currents, even up to a considerable height, are being influenced by the nature or conformation of the surface of the earth immediately beneath. For example, on one occasion, when at a height of 1,000ft. above Kent, he found it impossible to resist the conviction that he was for some miles strictly following a chalk ridge. Dealing with temperature measurements, Mr. Bacon informed his audience that the modern kite had proved that currents of warmer air are constantly to be met with within all accessible limits and in all conditions of weather. The most remarkable case of variation of temperature within a cloud is probably that experienced by Barral and Bixio, who recorded on penetrating a cloud mass a sudden fall of temperature from 15° to 39°.

By means of detonating gun-cotton from a balloon, the observing aeronaut appears to have established the fact fairly to his satisfaction that the sound was more audible across the wind than either directly up wind or down—a very remarkable conclusion. Perhaps the most singular of all his observations was that which had for its purpose the testing of the purity, that is, the freedom from dust in suspension, of atmospheric air collected in different places and altitudes. The sample most completely pure was taken from over the Scilly Islands. This is not altogether surprising, but it is very remarkable that one of the very purest samples was secured at the open end of the Aldersgate platform of the Metropolitan Railway, the explanation presumably being attributable to the passing trains attended with volumes of steam, which emitted under the roof would entrap and cleanse out the dust. Again, a sample collected on a still day at a height of 2,000ft. above Kingston was found to be considerably more heavily dust-laden than samples taken in the London streets on the following day. Alteration in the *timbre* of the voice is noticed by aeronauts, especially at high altitudes. This is very noticeable, the lecturer stated, when air is compressed.

In conclusion, Mr. Bacon made the following very interesting statement: He said that on several occasions he had been far aloft at cockcrow. The air has been calm and equable, and silence profound, and then in the darkness he has heard a challenge from a farmyard below. It is answered by a score of others in close neighbourhood, and then further afield, further yet, till from almost infinite distance the shrill penetrating calls still fall on the ear. The open country is to the eye of the aerial voyager without breach of continuity so far as neighbourhood of farmyards is concerned. From the fowl roost point of view all the land is a connected whole. When, then, at night any one single cock may crow, does a wave of crowing spread throughout all England? Mr. Bacon sees no escape from this—a very remarkable conclusion.

A short time since a balloon ascent was made from Sevenoaks in a terrific snowstorm. The ascent was a success, but it was found necessary to reduce the amount of ballast owing to the weight of snow on the top of the balloon.

# Aeronautical Show in Paris.

ONE of the most interesting sections of the recent Salon de l'Automobile in Paris was that devoted to aeronautical exhibits, which certainly were of much greater variety than had been seen on any previous occasion, and though the number of models exhibited was small, the drawings and photographs illustrating new systems nevertheless showed that inventors are giving increased attention to the question of aerial navigation. It is, of course, impossible to judge of the value of these systems from illustrations, or even from models, but it may be hoped that the number of new devices and theories which are being brought forward will at least help to lay the foundation of the new science of flight, though in many cases it may be in a negative sense by proving the weakness of theories that at present find a good many supporters. It is only by experimenting with every system, and examining the causes of failures as well as successes, that it will be possible to lay down general and well-defined principles which will result in a much more rapid progress towards a practical solution than can be expected at present. The only big machines exhibited were the Henry Deutsch navigable balloon and the keel of "La France," constructed more than twenty years ago by the brothers Renard for the French Government—that is to say, the first navigable balloon which ever travelled against the wind and returned to its starting point after making a circular journey, and the latest balloon constructed upon the most approved lines, and still waiting to take its first flight in the air. The bamboo keel of "La France" differs little in appearance from that designed by M. Tatin for the Henry Deutsch machine, but the electric motor develops considerably less power, not a quarter, we believe, of that given by the 40 h.p. Mors engine which is to drive the new balloon. In view of the dead weight that had to be carried by "La France" in the shape of storage batteries, necessitating, as it did, the employment of a big aerostat, the performances of MM. Renard's balloon must be regarded as really remarkable, and if successful journeys could have been made under these conditions, it may be expected that still better results will be obtained now that builders of navigable balloons have at their disposal considerably higher powers.

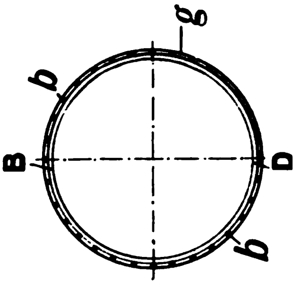
Flying machines were not strongly represented at the show, but an extremely simple form of heliosptère has been designed by M. Théophile Ballé, an engineer at Vire (Calvodos), who has for years been taking a practical interest in aerial navigation, and, believing that the problem can be satisfactorily solved by an elevating device, he has constructed a model of an aviator in which both the vertical and horizontal movements are effected by the same revolving propeller. The machine is composed essentially of two parts—a vertical framework or column containing the motors and driving-gear, and a horizontal propeller, which lifts the apparatus, and is inclined to drive it forward in any direction. The vertical part is built up of two rigid members slightly inclining inwards at the top and terminating in a bearing for the shaft of the revolving propeller. About a third of the way up the members are connected with cross pieces forming a support for the car, containing the motors and driving-gear, inside the principal members. The weight of the driver and mechanism being thus placed at the bottom, the greatest possible stability is given to the machine. As the space between the members above the car must be left free for the steering-gear, they are strengthened by side arms braced together by steel wire. The horizontal shaft of the propeller turns in the bearings at the top of the vertical frame, and at this point is connected at right angles with another shaft, which is free to move between the vertical members, and thus give any desired inclination to the horizontal propeller. To this vertical shaft is attached a large steering sail, which also serves as a counterforce, or rather a resistance to the action set up by the propeller, and tending to revolve the machine with it. With the large surface presented by the sail there is no danger of the machine being carried round by the centrifugal force of the propeller. Motion is given to the propeller by two motors; one attached to each of the side members, and gearing by means of two long tubular shafts and bevelled pinions, all this gear being enclosed and well lubricated. The idea of using two motors is to prevent accidents in the event of one of them failing to work. Both the sail and the propeller are operated by means of cables passing round a steering wheel in the car and then up round pulleys on the top of the frame. The propeller itself is made with a special form of blade, offering a very large surface, and having a great lifting capacity. They are surrounded by a cylinder to secure a maximum of efficiency, which would otherwise be lost by the rapid outward displacement of the air caused by the centrifugal force. Tests with a model of this new system of propeller blade are said to have given remarkably satisfactory results.

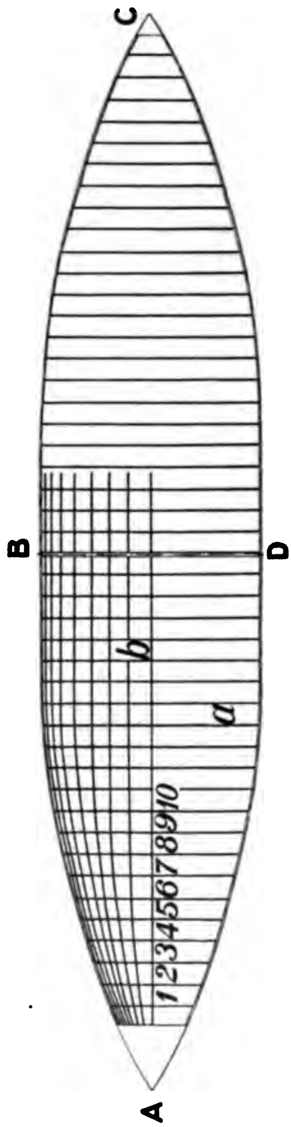
Another of M. Ballé's inventions is a specially designed dynamometer for measuring the lifting force of aerial propellers. This consists of a beam balance, at one end of which is fixed the propeller with its motor, and at the other a receptacle for the weights. When the motor is not running and the propeller is at rest a horizontal position is given to the beam by means of the weights. The electric motor is then run at a known speed and consequently developing a known force, and on the propeller rising the weights are removed to bring back the beam to a horizontal position. As the power of the motor and the lifting force of the propeller are known, it is easy to calculate the efficiency of the propeller for that speed, and on repeating the experiments at different speeds, and comparing the results, it is possible to establish formulæ giving the speed and area of propeller blades at which the highest efficiency can be obtained. This apparatus has been presented at the French Academy and at the Société Française de Navigation Aérienne. M. Ballé is now constructing another apparatus, which, besides giving the results stated above, will allow of a calculation being made of the weight which can be raised by a propeller at a certain speed and absorbing a certain force.

A model of a navigable balloon was exhibited by M. François-Contour, 32, Avenue Herbillon, Saint-Mandé (Seine), who employs an elongated balloon of large diameter, which is calculated to have dimensions of 24 mm. by 10 mm., so that the length is less than two and a half times the diameter. This gives a great resistance to the balloon, and avoids any possibility of its sagging and collapsing. At the same time, the large diameter naturally offers a greater resistance to the air than is the case with much longer and narrower balloons, but M. François-

Contour claims that this is more than compensated for by the fact that the form of the balloon dispenses with the necessity of carrying dead weight to ensure stability, and this weight is utilised instead in the propelling mechanism. Directly underneath the balloon is suspended the basket or car, which is contained in a frame of tubes. This frame rises up each side, and has bearings for a couple of shafts, parallel to the axis of the balloon, and carrying propellers at each end. The top of the frame is rigidly connected with the sides of the balloon. Longitudinal rigidity is also given by connections between the car and the ends of the aerostat, so that the balloon must necessarily follow the movements of the car. In a balloon of the dimensions given above the propellers are operated by a 40 h.p. motor inside the basket, and enclosed to avoid any possibility of danger from an escape of gas, and power is transmitted by belts passing over a pulley on each shaft. The aerostat is steered simply by varying the speed of the propellers, and it is easy to imagine that when one is revolving at a high rate of speed, and the other is at rest, the balloon can turn in a very short radius. The arrangement certainly seems to possess advantages, since the aeronaut has the motor close at hand, and, not being burdened with dead weight, he can carry plenty of fuel and any accessories he may need. The inventor has experimented with his system in a small balloon of 5 m. 50 by 2 m. 60, and propelled by an electric motor of only five kilogrammetres. Notwithstanding the low power employed, he states that the balloon was driven at the rate of twenty metres a second. It showed the greatest possible stability, and navigated without the slightest rolling or pitching movement. M. François-Contour argues that the results must necessarily be still more satisfactory in a large balloon of the dimensions stated above and cubing 1,200 metres.

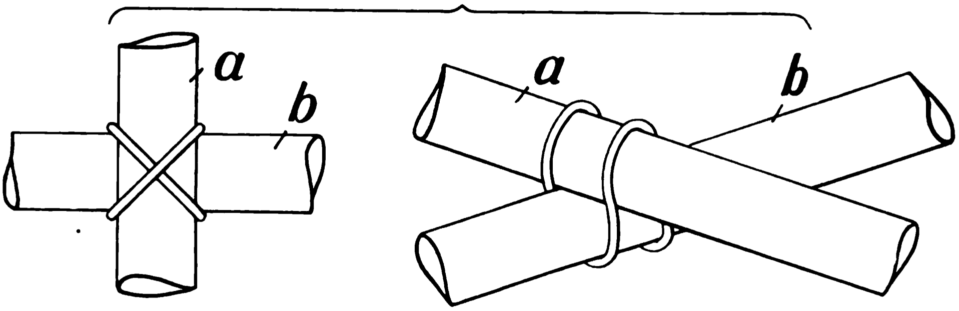
Another interesting exhibit was a working model of the famous twin navigable balloon invented and constructed by M. Roze, of Colombes (Seine). This machine differs from all other balloons of the kind from the fact that the aerostat does not raise the entire load, and merely assists by its buoyancy to lighten the load to be raised by the elevating propellers. Practically, therefore, the machine is heavier than air, and should commend itself to theorists who believe that the problem of aerial navigation can only be solved upon this principle. At the same time the Roze machine has two aerostats, and must therefore still be ranked among the category of navigable balloons. The original machine which carried out its trials last autumn is composed of two balloons, each having a length of 45 metres and a diameter in the centre of 7 m. As M. Roze considered that weight was only of comparatively minor importance in a machine of this kind, he designed his aerostats to secure the greatest strength, and made them with a rigid framework of aluminium covered with a double envelope of silk. There was consequently no danger of its deforming, and very little fear even of the cover tearing in the event of accident. Each is divided into twelve compartments, so as to prevent any displacement of gas interfering with the stability, but the corresponding compartments of both balloons are connected with tubes and valves to ensure a perfect equilibrium. Between the balloons is the car, capable of carrying eight passengers, besides the driver. It is divided into two compartments, the upper one for the passengers, and below is a 20 h.p. Buchet motor. The motorshaft gears on to the propeller shaft, which carries two propellers at each end. These propellers are of special form, and are the outcome of fifteen years' experiment. They have a diameter of 3 m. 20, and run at a maximum of 300 revolutions a minute. Above the car are two other propellers for elevating the machine. Another novel feature is the parachute, situated above the elevating propellers, and forming the top of the tubular frame containing the car. This has a close resemblance to a latticed window blind placed horizontally, with the lattices hanging downwards, when the machine is rising, or is taking its normal flight, but they are closed to form an aeroplane to allow of the machine skimming downwards in an oblique direction, or when it is necessary to slow the machine during a descent. It also assists in giving a longitudinal stability to the balloon. The length of the parachute is thirteen feet, and its width 2ft. 11in., which is about the same dimension as the car. The machine is steered by a large sail at the rear. The total weight of the apparatus is more than two and a half tons, and M. Roze expected that with the buoyancy of the balloons his elevating machinery would be amply sufficient to raise the load. Unfortunately, the trials last year entirely failed to bear out his conclusions. Even after lightening the machine as much as possible, it only just succeeded in clearing the ground for a few seconds, and then dropped heavily, and M. Roze saw that he would have to considerably reduce the weight before he could hope to make it a practical success, though, as the machine has cost an enormous sum of money during the two years it has been under construction, it is doubtful whether the inventor will be able to resume his experiments for some time to come.





The cigar-shaped aerostat shown by M. Paul Delaporte, 56, Rue de la Victoire, Paris, is composed of a framework of rubber tubes, which gives a certain rigidity to the envelope, and prevents it from deforming through any escape of gas or when the balloon is being driven against the wind. These tubes are covered with fabric, and when inflated hard with gas they are capable of resisting lateral strains, and serve the same purpose as a framework of wood or metal, at the same time that they are considerably lighter. The tubes are arranged longitudinally and vertically as shown in fig. 1, and are attached by wire hooks in the manner indicated in fig. 3, these hooks being of sufficient size to grip firmly on the tubes when inflated. Fig. 2 is a cross section of the aerostat showing the tubes *b* supporting the envelope *g*. The inflating is done by means of three feeder tubes—two longitudinal and one vertical, the former inflating the alternate vertical tubes, while the feeder B D is connected with all the longitudinal tubes. Each tube is fitted with a valve. The system is employed not only for aerostats but also for aeroplanes, wings, and other flying devices where the greatest lightness and rigidity are required. The tubes, in fact, serve the same purpose as the hollow quills of a bird's wing.

Fig. 3.



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## A Sad Fatality.

A terrible balloon accident recently occurred at Antwerp, whereby Lieutenant von Siegsteid, a well-known German military aeronaut, was killed, and Dr. Lincke, of Potsdam, injured. The balloon was caught in a fierce storm, and when fifteen feet from the ground Dr. Lincke sprang out of the car and escaped with slight injury. The lieutenant tried to follow his example, but, failing to clear the ropes, was dragged along the ground for nearly 200 yards. When finally the balloon was captured, the lieutenant was dead. He had received frightful injuries.

## The Highest Altitude.

Dr. Bersen and Dr. Suring, of the Berlin Meteorological Institute, have reached in a balloon ascent the highest altitude on record. They first went up to the height of 30,000ft., losing consciousness for brief intervals. In spite of the risk, they continued to ascend to 33,790ft., when one of them became completely unconscious, and could not be aroused. The other aeronaut, after making a great effort in opening the valve to descend, also became insensible, and neither of them recovered till the balloon dropped to 16,000ft., at the end of an hour's time.

## A Scottish Inventor.

Mr. G. W. Watson, a Berwickshire gentleman, has applied for letters patent for a flying machine. Although a description of his invention cannot be given until his patents are completed, it may be said that he has discarded the cigar or torpedo-shaped elevator for one which, while almost round, has a sharp outer edge. He claims with his machine to be able to sail straightly, angularly, or circuitously under any circumstances or conditions at any time. Suspended from the elevator is a wicker car, which will contain the prime motor and passengers. The invention is provided with an automatic parachute, which will enable the car to descend gently to earth in the event of accident to the elevator. Mr. Watson asserts his ability to carry forty-nine passengers across Europe, Asia, Africa, or America under any atmospheric conditions, and that the launching of his machine will upset all preconceived notions of aerial navigation. We hope to be able to give illustrated particulars regarding this machine in the next issue of *Flying*.

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## Something New.

A Frenchman, M. Sibillot, has deposited the plans of a new steerable balloon, which, he maintains, will be manageable in any weather. Under one cover he arranges a series of balloons, thus securing separate air-tight compartments. He proposes to carry with him a freezing and a heating apparatus. By simply pressing a button of the former he thus reduces the temperature of the gas, and allows the balloon to descend; on heating the hydrogen the effect is reversed. It is not stated whether provision has been made for a safe descent in the event of the hot or cold air machine failing in its prescribed duty.

## Scientific Ballooning.

### A Public Subscription Suggested.

“We have nowhere in England a balloon of a capacity sufficient to enable anyone to attempt scientific work on a par with that being followed upon the Continent,” writes the Rev. John M. Bacon, the distinguished aeronaut. “It would seem, too, that no public grant can in these days be obtained for such an object. Is it possible to open a public subscription with a view of placing ourselves on an equality with other nations? I have long entertained the idea that it would be very possible to survey and photograph from a balloon a track from W. to E. across the unexplored parts of Arabia, and I am myself, with due equipment, prepared to make the attempt. Besides an adequate ballcon, some organised outlook would have to be arranged on the seaboard. Moreover, it would be well, as a preliminary experiment, to launch an unmanned balloon, with automatic discharge of ballast, from the chosen point of departure and determine its course. Could a subscription be started for this enterprise?” We are of opinion that Mr. Bacon is perfectly right in assuming that no public grant will be made, as the Government of this country has a profound belief in the possibilities of private enterprise. We should imagine, however, that there are many in Britain who will be glad to assist him in his project. It is to be hoped that Mr. Bacon's scheme will have a successful issue, for if it does there is no doubt that many others will follow in the wake of the well-known aeronaut, and the results should be of great geographical value. Major Baden-Powell, the president of the Aeronautical Society, suggested a very similar project in 1898. He proposed to cross the Soudan photographing and mapping *en route*.

# Some Aeronautical Experiments.

## A Paper read by Mr. Wilbur Wright, Dayton, Ohio, before the Western Society of Engineers.

### INTRODUCTION BY PRESIDENT CHANUTE.

ENGINEERS have, until recent years, fought shy of anything relating to aerial navigation. Those who ventured, in spite of the odium attached to that study, to look into it at all, became very soon satisfied that the great obstacle in the way was the lack of a motor sufficiently light to sustain its weight, and that of an aeroplane, upon the air. Fifteen years ago the lightest steam motor was the marine engine weighing 60 lbs. to the horse-power, while the gas engine weighed very much more; the locomotive weighed 200 lbs. per horse-power. During the past fifteen years a great change has taken place. Steam motors have been produced weighing only 10 lbs. per horse-power, and gas engines have been lightened down to 12½ lbs. to 15 lbs. per horse-power, so that the status, so far as engineers are concerned, is very greatly changed, and there is some hope that, for some limited purposes at least, man will eventually be able to fly through the air. There is, however, before that can be carried out—before a motor can be applied to a flying machine—an important problem to solve—that of safety, or that of stability.

I had the honour of telling you, some four or five years ago, something about the progress that had been made up to that time. Since then further advances have been made by two gentlemen from Dayton, Ohio—Mr. Wilbur Wright and Mr. Orville Wright, who tried some very interesting experiments in October, 1900, about a year ago. These experiments were conducted on the sea shore of North Carolina, and were again resumed last July. These gentlemen have been bold enough to attempt some things which neither Lilienthal nor Pilcher nor myself dared to do. They have used surfaces very much greater in extent than those which hitherto had been deemed safe, and they have accomplished very remarkable results, part of which it was my privilege to see on a visit which I paid to their camp about a month ago.

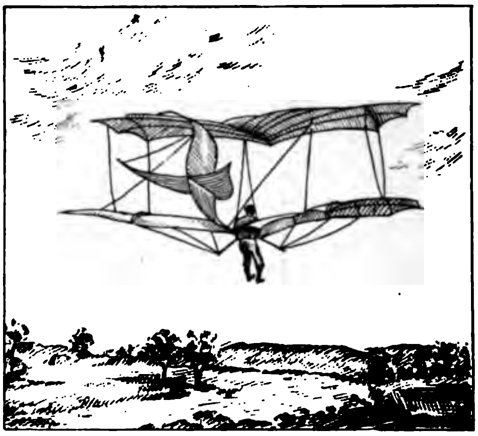
I thought it would be interesting to the members of this society to be the first to learn of the results accomplished, and, therefore, I have the honour of presenting to you Mr. Wilbur Wright.

### THE PAPER.

The difficulties which obstruct the pathway to success in flying machine construction are of three general classes: (1) Those which relate to the construction of the sustaining wings. (2) Those which relate to the generation and application of the power required to drive the machine through the air. (3) Those relating to the balancing and steering of the machine after it is actually in flight. Of these difficulties two are already to a certain extent solved. Men already know how to construct wings or aeroplanes, which when driven through the air at sufficient speed, will not only sustain the weight of the wings themselves, but also that of the engine, and of the engineer as well. Men also know how to build engines and screws of sufficient lightness and power to drive these planes at sustaining speed. As long ago as 1893 a machine weighing 8,000 lbs. demonstrated its power both to lift itself from the ground and to maintain a speed of from thirty to forty miles per hour; but it came to grief in an accidental free flight, owing to the inability of the operators to balance and steer it properly. This inability to balance and steer still confronts students of the flying problem, although nearly ten years have passed. When this one feature has been worked out the age of flying machines will have arrived, for all other difficulties are of minor importance.

The person who merely watches the flight of a bird gathers the impression that the bird has nothing to think of but the flapping of its wings. As a matter of fact, this is a very small part of its mental labour. To even mention all the things the bird must constantly keep in mind in order to fly securely through the air would take a considerable part of the evening. If I take this piece of paper, and after placing it parallel with the ground, quickly let it fall, it will not settle steadily down as a staid, sensible piece of paper ought to do, but it insists on contravening every recognised rule of decorum, turning over and darting hither and thither in the most erratic manner, much after the style of an untrained horse. Yet this is the style of steed that men must learn to manage before flying can become an everyday sport. The bird has learned this art of equilibrium, and learned it so thoroughly that its skill is not apparent to our sight. We only learn to appreciate it when we try to imitate it. Now, there are two ways of learning how to ride a fractious horse: one is to get on him and learn by actual practice how each motion and trick may be best met; the other is to sit on a fence and watch the beast awhile, and then retire to the house and at leisure figure out the best way of overcoming his jumps and kicks. The latter system is the safest; but the former, on the whole, turns out the larger proportion of good riders. It is very much the same in learning to ride a flying machine; if you are looking for perfect safety, you will do well to sit on a fence and watch the birds; but if you really wish to learn, you must mount a machine and become acquainted with its tricks by actual trial.

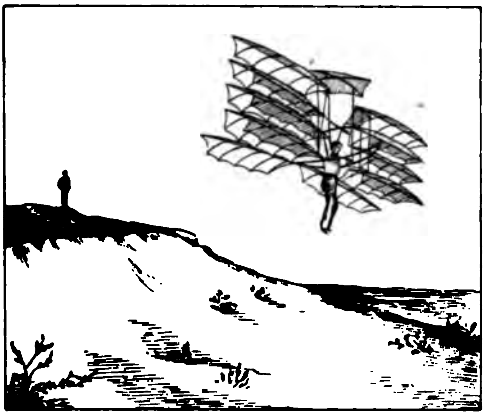
Herr Otto Lilienthal seems to have been the first man who really comprehended that balancing was the ***first***, instead of the ***last***, of the great problems in connection with human flight. He began where others left off, and thus saved the many thousands of dollars that it had theretofore been customary to spend in building and fitting expensive engines to machines which were uncontrollable when tried. He built a pair of wings of a size suitable to sustain his own weight, and made use of gravity as his motor. This motor not only cost him nothing to begin with, but it required no expensive fuel while in operation, and never had to be sent to the shop for repairs. It had one serious drawback, however, in that it always insisted on fixing the conditions under which it would work. These, were, that the man should first betake him-



Lilienthal's Machine.

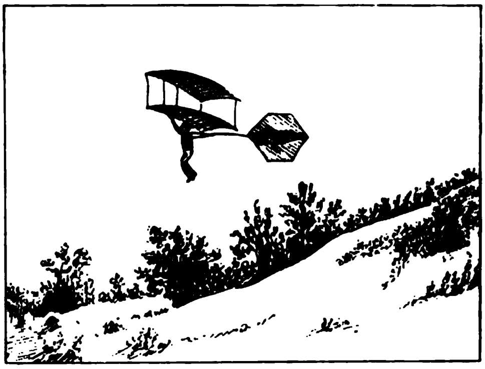
self and machine to the top of a hill and fly with a downward, as well as a forward, motion. Unless these conditions were complied with, gravity served no better than a balky horse—it would not work at all. Although Lilienthal must have thought the conditions were rather hard, he nevertheless accepted them till something better should turn up; and in this manner he made some two thousand flights, in a few cases landing at a point more than a thousand feet distant from his place of starting. Other men, no doubt, long before had thought of trying such a plan. Lilienthal not only thought, but acted, and in so doing probably made the greatest contribution to the solution of the flying problem that has ever been made by any one man. He demonstrated the feasibility of actual practice in the air, without which success is impossible. Herr Lilienthal was followed by Mr. Pilcher, a young English engineer, and by Mr. Chanute, a distinguished member of the society I now address. A few others have built machines, but nearly all that is of real value is due to the experiments conducted under the direction of the three men just mentioned.

The balancing of a gliding or flying machine is very simple in theory. It merely consists in causing the centre of pressure to coincide with the centre of gravity. But in actual practice there seems to be an almost boundless incompatibility of temper which prevents their remaining peaceably together for a single instant, so that the operator, who in this case acts as peacemaker, often suffers injury to himself while attempting to bring them together. If a wind strikes a vertical plane, the pressure on that part to one side of the centre will exactly balance that on the other side, and the part above the centre will balance that below. This point we call the centre of pressure. But if the plane be slightly inclined, the pressure on the part nearest the wind is increased, and the pressure on the other part decreased, so that the centre of pressure is now located, not in the centre of the surface, but a little toward the side which is in advance. If the plane be still further inclined, the centre of pressure will move still farther forward. And if the wind blow a little to one side, it will also move over as if to meet it. Now, since neither the wind nor the machine for even an instant maintains exactly the same direction and velocity, it is evident that the man who would trace the course of the centre of pressure must be very quick of mind; and he who would attempt to move his body to that spot at every change must be very active indeed. Yet this is what Herr Lilienthal attempted to do, and did do with most remarkable skill, as his two thousand glides sufficiently attest. However, he did not escape being overturned by wind gusts several times, and finally lost his life through a breakage of his machine, due to defective construction. The Pilcher machine was similar to that of Lilienthal, and like it, seems to have been structurally weak; for on one occasion, while exhibiting the flight of his machine to several members of the Aeronautical Society of Great Britain, it suddenly collapsed and fell to the ground, causing injuries to the operator which proved sadly fatal. The method of management of this machine differed in no important respect from that of Lilienthal, the operator shifting his body to make the centres of pressure and gravity coincide. Although the fatalities which befell the designers of these machines were due to the lack of structural strength, rather than to lack of control, nevertheless it had become clear to the students of the problem that a more perfect method of control must be evolved. The Chanute machines marked a great advance in both respects. In the multiple wing machine, the tips folded slightly backward under the pressure of wind gusts, so that the travel of the centre of pressure was thus largely counterbalanced. The guiding of the machine was done by a slight movement of the operator's body toward the direction in which it was desired that the machine should go. The double deck machine built and tried at the same time marked a very great structural advance, as it was the first in which the principles of the modern truss bridges were fully applied to flying machine construction. This machine, in addition to its greatly improved construction and general design of parts, also differed from the machine of Lilienthal in the operation of its tail. In the Lilienthal machine the tail, instead of being fixed in one position, was prevented by a stop from folding downward beyond a certain point, but was free to fold upward without any hindrance. In the Chanute machine the tail was at first rigid, but afterward, at the suggestion of Mr. Herring, it was held in place by a spring that allowed it to move slightly either upward or downward with reference to its normal position, thus modifying the action of the wind gusts upon it, very much to its advantage. The guiding of the machine was effected by slight movements of the operator's body, as in the multiple wing machines. Both these machines were much more manageable than the Lilienthal type, and their structural strength, notwithstanding their extreme lightness, was such that no fatalities, or even accidents, marked the glides made with them, although winds were successfully encountered much greater in violence than any which previous experimenters had dared to attempt.



Chanute's Multiple-wing Machine.

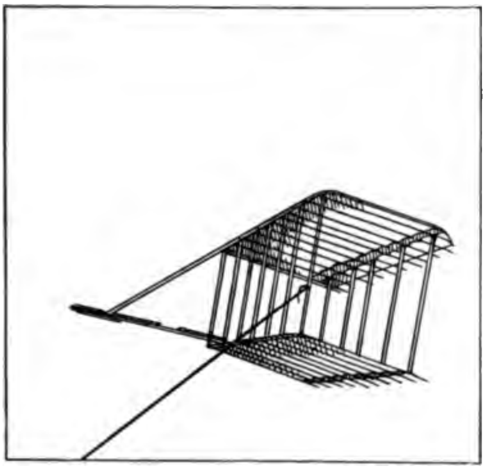
My own active interest in aeronautical problems dates back to the death of Lilienthal in 1896. The brief notice of his death which appeared in the telegraphic news at that time aroused a passive interest which had existed from my childhood, and led me to take down from the shelves of our home library a book on "Animal Mechanism," by Prof. Marey, which I had already read several times. From this I was led to read more modern works, and as my brother soon became equally interested with myself, we soon passed from the reading to the thinking, and finally to the working stage. It seemed to us that the main reason why the problem had remained so long unsolved was that no one had been able to obtain any adequate practice. We figured that Lilienthal in five years of time had spent only about five hours in actual gliding through the air. The wonder was not that he had done so little, but that he had accomplished so much. It would not be considered at all safe for a bicycle rider to attempt to ride through a crowded city street after only five hours' practice, spread out in bits of ten seconds each over a period of five years; yet Lilienthal with this brief practice was remarkably successful in meeting the fluctuations and eddies of wind gusts. We thought that if some method could be found by which it would be possible to practise by the hour, instead of by the second, there would be hope of advancing the solution of a very difficult problem. It seemed feasible to do this by building a machine which would be sustained at a speed of eighteen miles per hour, and then finding a locality where winds of this velocity were common. With these conditions, a rope attached to the machine to keep it from floating backward would answer very nearly the same purpose as a propeller driven by a motor, and it would be possible to practise by the hour, and without any serious danger, as it would not be necessary to rise far from the ground, and the machine would not have any forward motion at all. We found, according to the accepted tables of air pressures on curved surfaces, that a machine spreading 200 square feet of wing surface would be sufficient for our purpose, and that places could easily be found along the Atlantic coast where winds of sixteen to twenty-five miles were not at all uncommon. When the winds were low, it was our plan to glide from the tops of sand hills, and when they were sufficiently strong, to use a rope for our motor and fly over one spot. Our next work was to draw up the plans for a suitable machine. After much study we finally concluded that tails were a source of trouble rather than of assistance; and therefore we decided to dispense with them altogether. It seemed reasonable that if the body of the operator could be placed in a horizontal position, instead of the upright, as in the machines of Lilienthal, Pilcher, and Chanute, the wind resistance could be very materially reduced, since only one square foot, instead of five, would be exposed. As a full half horse-power could be saved by this change, we arranged to try at least the horizontal position. Then the method of control used by Lilienthal, which consisted in shifting the body, did not seem quite as quick or effective as the case required; so, after long study, we contrived a system consisting of two large surfaces on the Chanute double deck plan, and a smaller surface placed a short distance in front of the main surfaces in such a position that the action of the wind upon it would counterbalance the effect of the travel of the centre pressure on the main surfaces. Thus changes in the direction and velocity of the wind would have little disturbing effect, and the operator would be required to attend only to the steering of the machine, which was to be effected by curving the forward surface up or down. The lateral equilibrium and the steering to right or left was to be attained by a peculiar torsion of the main surfaces, which was equivalent to presenting one end of the wings at a greater angle than the other. In the main frame a few changes were also made in the details of construction and trussing employed by Mr. Chanute. The most important of these were (1) the moving of the forward main cross-piece of the frame to the extreme front edge; (2) the encasing in the cloth of all cross-pieces and ribs of the surfaces;



Chanute's Double-deck Machine.

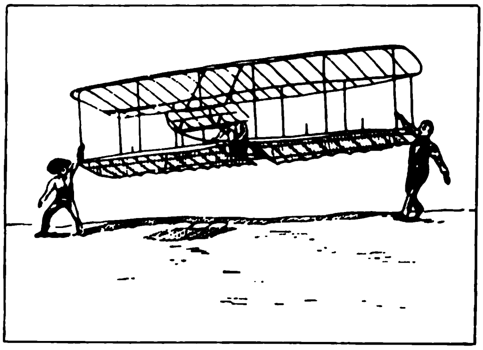
(3) a re-arrangement of the wires used in trussing the two surfaces together, which rendered it possible to tighten all the wires by simply shortening two of them.

With these plans we proceeded in the summer of 1900 to Kitty Hawk, North Carolina, a little settlement located on the strip of land that separates Albemarle Sound from the Atlantic Ocean. Owing to the impossibility of obtaining suitable material for a 200 square foot machine, we were compelled to make it only 165 square feet in area, which, according to the Lilienthal tables, would be supported at an angle of three degrees in a wind of about twenty-one miles per hour. On the very day that the machine was completed the wind blew from twenty-five to thirty miles per hour, and we took it out for a trial as a kite. We found that while it was supported with a man on it in a wind of about twenty-five miles, its angle was much nearer twenty degrees than three degrees. Even in gusts of thirty miles the angle of incidence did not get as low as three degrees, although the wind at this speed has more than twice the lifting power of a twenty-one mile wind. As winds of thirty miles per hour are not plentiful on clear days, it was at once evident that our plan of practising by the hour, day after day, would have to be postponed. Our system of twisting the surfaces to regulate the lateral balance was tried and found to be much more effective than shifting the operator's body. On subsequent days, when the wind was too light to support the machine with a man on it, we tested it as a kite, working the rudders by cords reaching to the ground. The results were very satisfactory, yet we were well aware that this method of testing is never wholly convincing until the results are confirmed by actual gliding experience.


The 1900 Machine.

We then turned our attention to making a series of actual measurements of the lift and drift of the machine under various loads. So far as we were aware, this had never previously been done with any full-size machine. The results obtained were most astonishing, for it appeared that the total horizontal pull of the machine, while sustaining a weight of 52 lbs., was only 8.5 lbs., which was less than had previously been estimated for head resistance of the framing alone. Making allowance for the weight carried, it appeared that the head resistance of the framing was but little more than fifty per cent. of the amount which Mr. Chanute had estimated as the head resistance of the framing of his machine. On the other hand, it appeared sadly deficient in lifting power as compared with the calculated lift of curved surfaces of its size. This deficiency we supposed might be due to one or more of the following causes: (1.) That the depth of the curvature of our surfaces was insufficient, being only about one in twenty-two, instead of one in twelve. (2.) That the cloth used in our wings was not sufficiently air-tight. (3.) That the Lilienthal tables might themselves be somewhat in error. We decided to arrange our machine for the following year, so that the depth of curvature of its surfaces could be varied at will, and its covering air-proofed.

Our attention was next turned to gliding, but no hill suitable for the purpose could be found near our camp at Kitty Hawk. This compelled us to take the machine to a point four miles south, where the Kill Devil sand hill rises from the flat sand to a height of more than 100 feet. Its main slope is toward the north-east, and has an inclination of ten degrees. On the day of our arrival the wind blew about twenty-five miles an hour, and as we had had no experience at all in gliding, we deemed it unsafe to attempt to leave the ground. But on the day following, the wind having subsided to fourteen miles per hour, we made about a dozen glides. It had been the original intention that the operator should run with the machine to obtain initial velocity, and assume the horizontal position only after the machine was in free flight. When it came time to land he was to resume the upright position and light on his feet, after the style of previous gliding experimenters. But on actual trial we found it much better to employ the help of two assistants in starting, which the peculiar form of our machine enabled us readily to do, and in landing we found that it was entirely practicable to land while still reclining in a horizontal position upon the machine. Although the landings were made while moving at speeds of more than twenty miles an hour, neither machine nor operator suffered any injury. The slope of the hill was 9.5 degrees, or a drop of one foot in six. We found that after attaining a speed of about twenty-five or thirty miles with reference to the wind, or ten to fifteen miles over the ground, the machine not only glided parallel to the slope of the hill, but greatly increased its speed, thus indicating its ability to glide on a somewhat less angle than 9.5 degrees, when we should feel it safe to rise higher from the surface. The control of the machine proved even better than we had dared to expect, responding quickly to the slightest motion of the rudder. With these glides our experiments for the year 1900 closed. Although the hours and hours of practice we had hoped to obtain finally dwindled down to about two minutes, we were very much pleased with the general results of the trip, for setting out as we did, with almost revolutionary theories on many points, and an entirely untried form of machine, we considered it quite a point to be able to return without having our pet theories completely knocked in the head by the hard logic of experience, and our own brains dashed out in the bargain. Everything seemed to us to confirm the correctness of our original opinions, (1) that practice is the key to the secret of flying; (2) that it is practicable to assume the horizontal position; (3) that a smaller surface set at a negative angle in front of the main bearing surfaces, or wings, will largely counteract the effect of the fore and aft travel of the centre of pressure; (4) that



Starting a Flight.

steering up and down can be attained with a rudder, without moving the position of the operator's body; (5) that twisting the wings so as to present their ends to the wind at different angles is a more prompt and efficient way of maintaining lateral equilibrium than shifting the body of the operator.

*(To be concluded.)*

# The World's Fair at St. Louis.

IT has been fully and finally determined to have a tournament of airships and an aerostatic congress at the world's fair, to be held at St. Louis in 1903. In order to stimulate inventors along this special line of experiment, prizes aggregating $200,000 will be offered for the most successful contestants.

When the classification of exhibits was prepared by Mr. Frederick J. V. Skiff, director of exhibits, he included in the department of transportation, in group 77, four classes of exhibits relating to aerial navigation. Class 481 relates to balloon construction, fabrics, varnish, cars, valves, netting, cordage, appliances for stopping balloons, such as anchors and grapnels, the generation of hydrogen and other light gases, and captive balloons. Class 482 relates to aerial voyages, the use of balloons for the study of the atmosphere, air currents, clouds, temperature at great heights, optical phenomena, drawings, maps of journeys, diagrams, photographs, etc. Class 483 relates to military ballooning, military captive balloons and their accessories, winding drums, transport waggons, and apparatus for inflation. Class 484 relates to aerial navigation, dirigible balloons, guiding apparatus, flying machines, screw propellers, aeroplanes, and parachutes. The fourth class mentioned is the one having a particular public interest at the present time.

A cablegram from London says that Sir Hiram S. Maxim has expressed himself as being willing to expend $100,000, in addition to the large sums he has already laid out, in experiments in aerial navigation to be won in the coming contest.

The announcement that such a liberal sum would be set aside for the encouragement and experiments in aerial navigation has stirred up a very lively interest in the science, and many enquiries have been received by mail and wire at Exposition headquarters. Secretary Stevens reports that it is possible there will be at least one hundred entries, representing not less than ten countries.

* * *

The difficulty in producing a true flying machine is infinitely greater than that encountered in producing a dirigible balloon, but Sir Hiram Maxim is of opinion that the dirigible balloon of the Santos-Dumont type will lead to the development of a true flying machine, in which the gas bag will be eliminated.

The recent death of Commander John Powles Cheyne, R.N., removes an old arctic explorer, who must always be remembered as having been the first to seriously suggest the use of a balloon, in the navigation of which he was an expert, in the search for the North Pole—a suggestion which the ill-fated André accepted.

# Short Flights.

British military ballooning is perhaps second to none. This is due to the energies of Colonel Templer and Major Trollope.

× × × ×

Probably the most interesting lecturer on aeronautics is the Rev. J. M. Bacon, whose balloon experiences are as varied as they are remarkable.

× × × ×

The Royal Meteorological Society intend sending up during dense London fogs captive balloons with a view of ascertaining how high an average fog extends, of noting the humidity and temperature of the various altitudes, and making other observations.

× × × ×

Not Morocco bound, but apparently very much up to date, is the Sultan of that country, taking a line through his recent European purchases, which consist of automobiles, motor bicycles, and a spacious captive balloon. Attached to the balloon is a telephone, which will enable the Sultan while in the air to communicate with his palace.

× × × ×

Colonel Cody is engaged in experimenting with a war kite he has invented, and which the Government are taking up. He was not particularly successful at Worcester and Bury St. Edmunds a few weeks ago, but more recently he succeeded in sending up a kite to an altitude of over 1,000ft. in a wind travelling at not more than three and a half miles an hour, and this enabled him to travel across the green on a three-wheeled carriage at a fairly good walking pace. Three hundred feet is the highest he himself has ascended in the kite hitherto, but before long Colonel Cody hopes to reach 1,000ft.

Russia now possesses a school of military ballooning.

× × × ×

A balloon race would form an exciting and useful sport. Such a race has already been suggested by several members of the Aero Club.

× × × ×

The Llandudno Town Improvement Association have unanimously decided to invite M. Santos-Dumont to Llandudno during the coming season with his airship. Llandudno Bay would form a fine expanse across which the aeronaut could wing his flight.

× × × ×

It is stated that the Scientific Committee of the Aéro Club Paris is preparing an important series of surgical experiments to be made at various altitudes. Special balloon cars are to be fitted with all the essentials of an operating room. Various problems of heart action under anæsthesia and subsequent recuperation are to be worked out. The first subjects will be guinea pigs and a dog.

× × × ×

It is stated that Santos-Dumont—whose Christian name, by the way, is Alberto—was first attracted towards aeronautics when a small child, and used to launch flotillas of diminutive balloons. A story goes that when he was twelve years old he bribed a wandering aeronaut, who was preparing to ascend from a village square, and he consented to take the lad with him. Unluckily, before the start, his tutor discovered him crouching in the basket to avoid detection, and he was hauled out in time, so his money went up and he did not. However, he has found means to ascend often enough in after life.

A writer in *The Outlook* states that the model which inventors of flying machines should follow is that of the partridge.

× × × ×

Last month some Italian peasants, noticing a balloon being carried rapidly towards the sea, caught the guide ropes and succeeded in bringing it down. Inside were a captain and a lieutenant, both unconscious. The balloon, which was being used for military purposes, had ascended in the morning.

× × × ×

The advent of kites into modern science may be said to have been in 1883, when Mr. E. D. Archibald, of Tunbridge Wells, showed how to secure with them all kinds of meteorological data, and actually executed important measurements of wind velocity at various elevations by means of anemometers fastened to the kite-wire, which he used in preference to string.

× × × ×

We hear that several new airships are to be launched into space in the near future. One is the invention of a well-known automobilist, M. Girardot, whose design embodies at least one very reasonable and practical idea. Another is designed by an Austrian, Herr Nimführ, who is the possessor of a wonderful, perhaps unique, motor, and who leans towards the theory of flight without the balloon.

× × × ×

A mechanic in the town of Archangel invented a flying machine and went to the local police to ask permission to use it. He was afraid he would get into trouble if he began to fly without a license. The head of the police consulted his law books, wrote to St. Petersburg for a later edition, and finally told the inventor that, as the law nowhere permits a machine to fly through the air, he must decline to establish a precedent.

A new balloon for the exploration of the Sahara Desert is about to be made by Colonel Debureau, an officer of engineers, who has devised an ingenious scheme for the automatic discharge of water ballast. This device will open a safety valve automatically, when the balloon descends, and keep the flying machine up. The gallant officer expects to travel a long way close to the ground, so as to reach the French stations in succession.

× × × ×

Until a few years ago steel was the strongest material for its weight which could be obtained, but recent experiments with aluminium show that this light metal can be made quite as strong as wrought iron by the addition of a small percentage of magnesium, that the compound is lighter than pure aluminium, and that it has the tensile strength and stiffness of wrought iron. Thus the engineer is put in possession of a very light and powerful motor and a light and strong material, which was quite unobtainable a few years ago.

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# Flying.

ILIFFE & SONS LIMITED,
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THE LATE SENOR SEVERO.

# Flying.

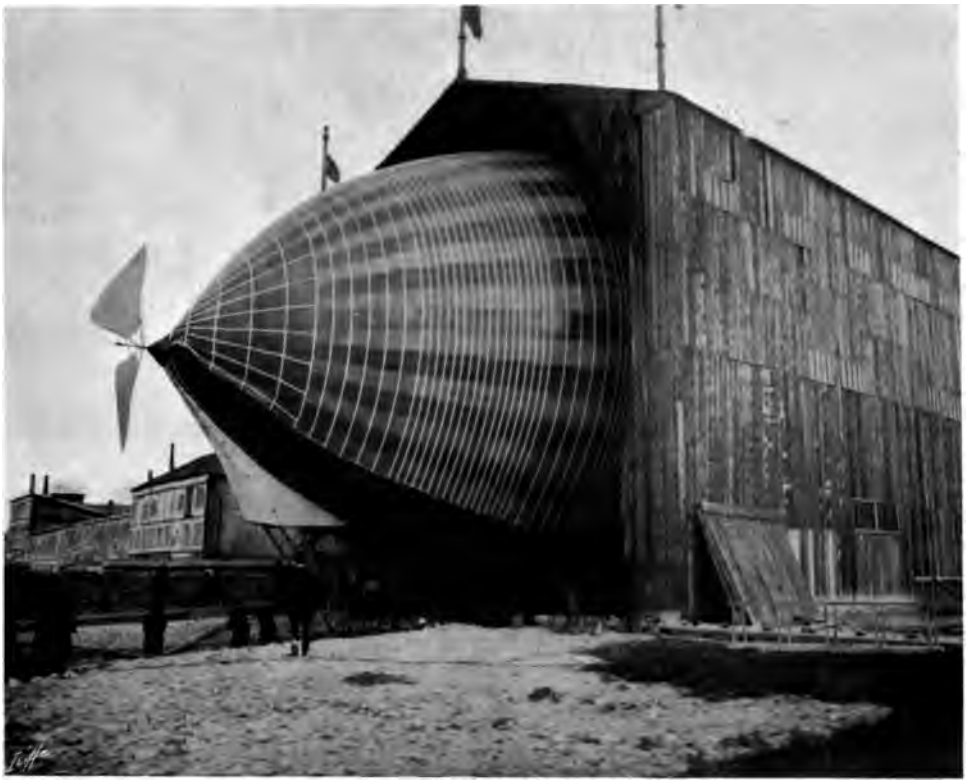
## The Record of Aerial Navigation.

WITH WHICH ARE INCORPORATED

**The Flyer, The Flying Machine, The Aerostat, The Aeronaut.**

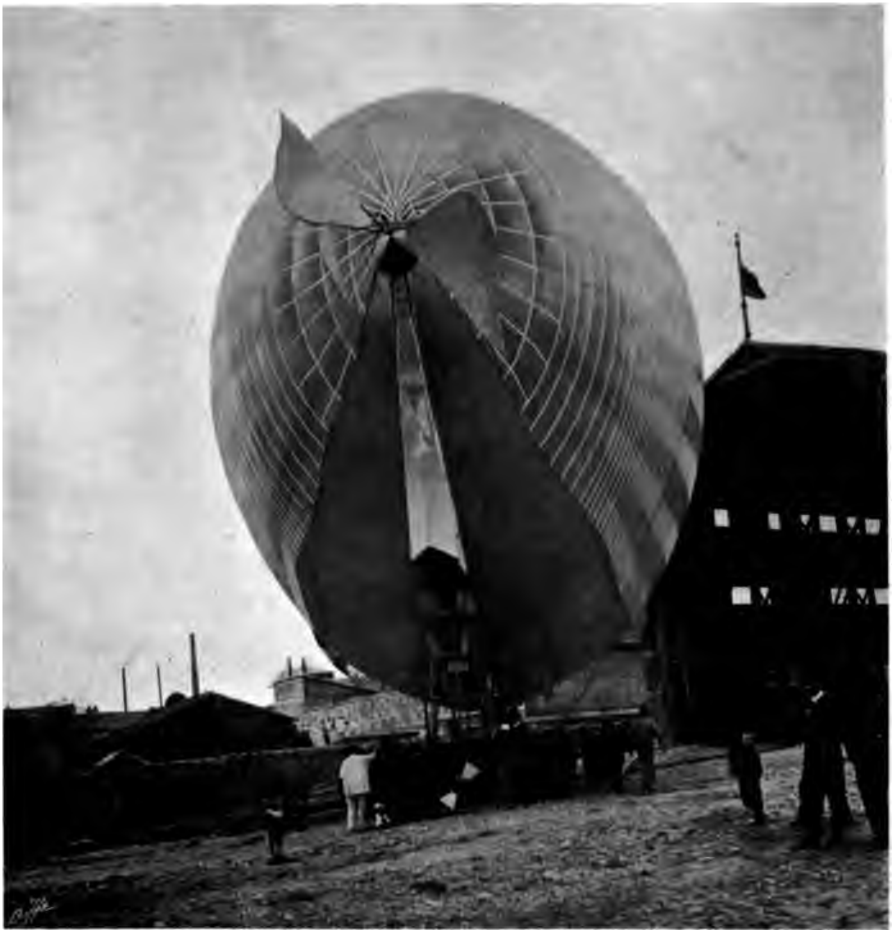
No. 3. QUARTERLY. JUNE, 1902.

# Destruction of the Severo Navigable Balloon.



THE "PAX" ISSUING FROM ITS SHED.

OF the many fatal accidents which have marked the history of ballooning, none are more lamentable than the untimely end of the "Pax," which ignited in mid-air on May 12th, and precipitated Senor Severo and his assistant, Saché, from a height of about 1,200 feet. For a long time aeronauts had been looking forward with great interest to the performance of the new navigable balloon. While Santos-Dumont was carrying out his experiments, a Brazilian deputy, Severo, who had closely associated himself with aeronautics, and had twenty years previously constructed a motor balloon, which was destroyed in a storm at Rio de Janeiro, argued that his countryman was not working out the problem on practical lines. Since stability is a very necessary factor in a motor balloon, Severo suggested that the only way of preventing plunging and swaying movements was to drive the balloon from its axis. He held that when the propelling mechanism is suspended from the aerostat it is impossible to drive the balloon horizontally, except by a system of guide ropes or movable ballast, and as the weight of the ballast must be more or less proportionate to the power of the motor there is a limit to the driving force in this type of balloon. Poor Severo went to Paris in the autumn of 1901 with his plans for a navigable balloon, which was constructed at Vaugirard by M. Lachambre.

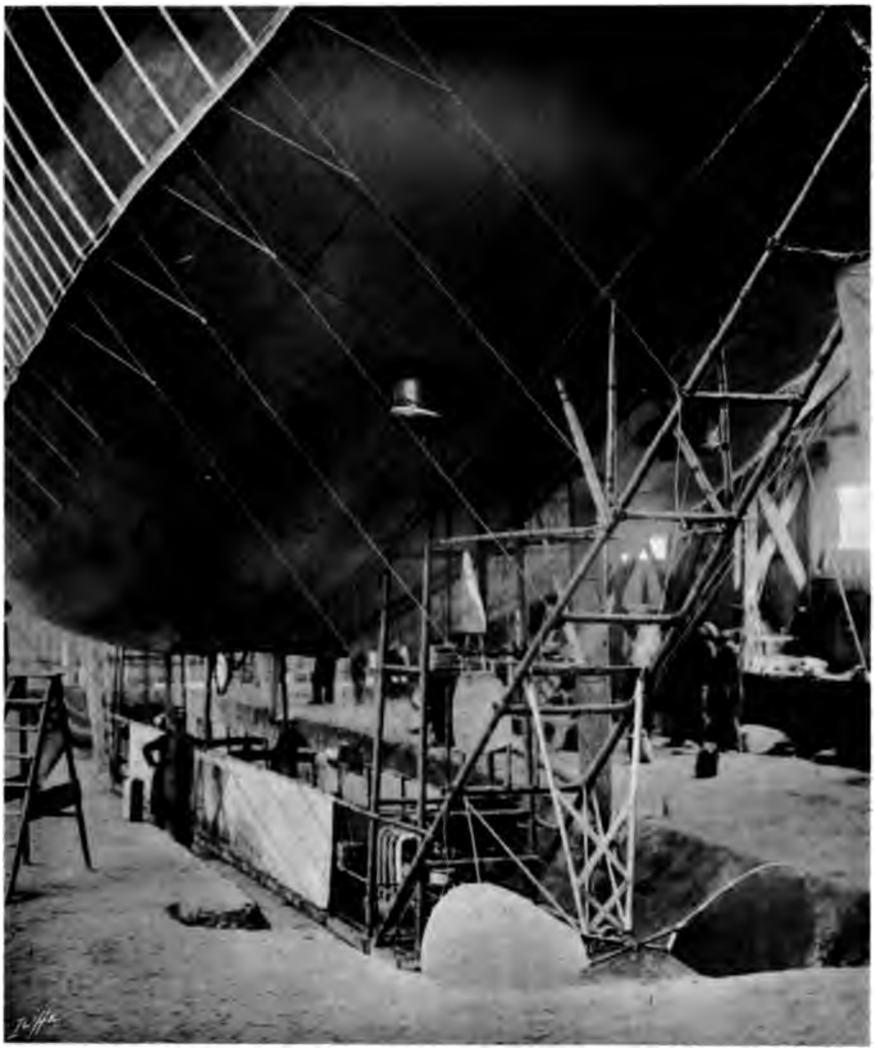


PREPARING FOR THE ASCENT.

## THE CONSTRUCTION OF THE "PAX."

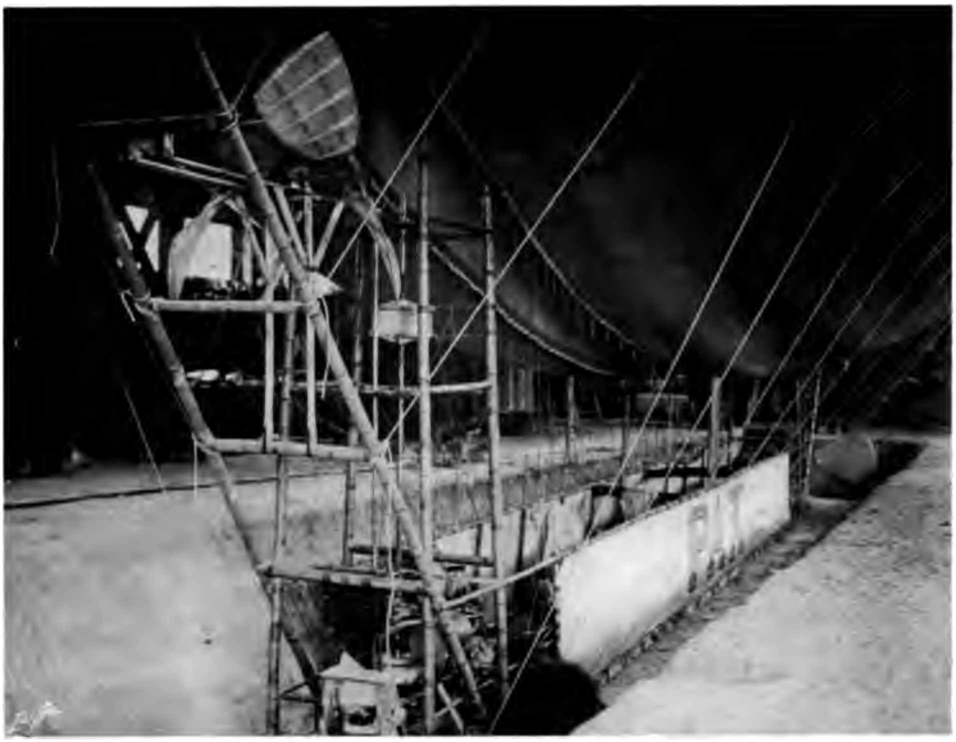
The airship differed entirely from anything that had been previously constructed.

The aerostat itself had a length of 98 feet, and a largest diameter, about two-thirds from the propelling end, of 39 feet. Its capacity was 2,400 cubic metres. The balloon was built on a bamboo framework in the form of a trapezoid, of which the base constituted the keel. At each end of the keel was a standard composed of four bamboo poles tapering up to the axis of the balloon, and connected by a horizontal rod, which was supported in the centre by a lighter standard constructed in the same way, with four poles from the keel braced diagonally. From each of the end standards horizontal rods also went to the ends of the balloon, and carried bearings for the driving shafts. There were two other outside bamboo supports from the ends of the keel to the ends of the axis, at the points where bearings were carried for the pro-



A VIEW OF THE "PAX," SHOWING PROPELLER AND CAR.

pellers. The main vertical standards, the horizontal rods, and the outside supports forming right angle triangles at each end of the keel were strongly braced diagonally with bamboo poles and wire. The keel itself was about half the length of the balloon, and was intended to carry several passengers, the total load which the balloon was expected to raise being nearly 32 cwts. On this framework was placed the aerostat itself, and a section had to be cut away underneath the balloon from its axis to allow of the insertion of the frame, so that the lower half was practically in two parts. The balloon was propelled by two Buchet four-cylinder, water-cooled motors. The engines were bolted to light beds of steel strip. The one in front developed 16 h.p., and the motorshaft geared by bevelled pinions on to two vertical shafts, the longer one being carried in the end standard. Power was transmitted by this long shaft to the horizontal shaft at the axis, carrying a wing-shaped propeller, which was intended to displace the air and thus prevent any unequal external pressure from sagging the balloon. The shorter shaft drove a pair of vertical fans underneath the balloon for steering. At the other end of the keel was a 24 h.p. motor, geared in exactly the same way to a second pair of steering fans and to the propeller, which had a diameter of nearly twenty feet. The motorshaft also actuated a small "compensating" propeller, that was intended to overcome air resistance when tacking. There were thus seven propellers and fans, which could all be driven separately.



ANOTHER VIEW IN WHICH ONE OF THE MOTORS IS CLEARLY SHOWN.

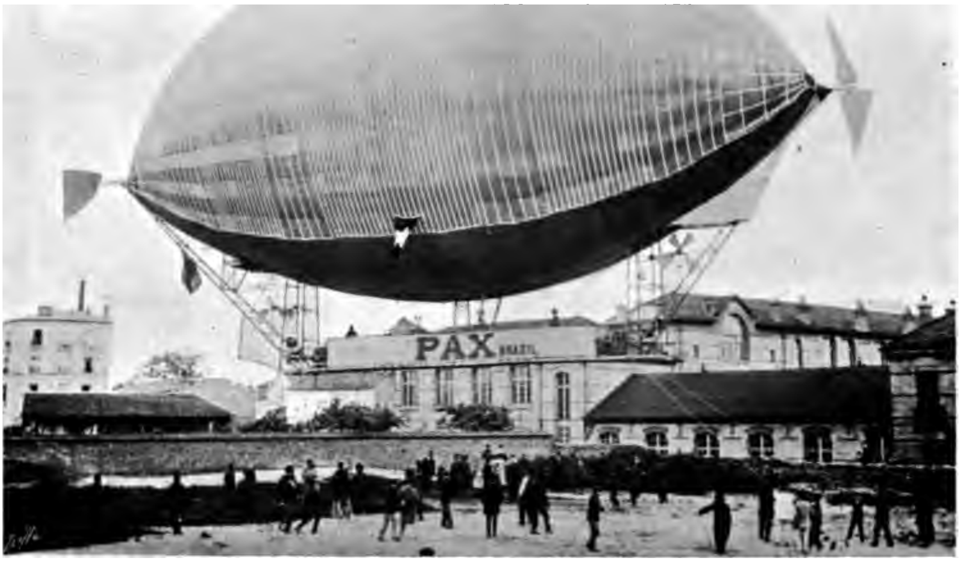
### THE FATAL TRIAL.

While the balloon was in course of construction several well-known aeronauts suggested to Senor Severo the wisdom of modifying the design of the machine, as they considered that the proximity of the motor to the aerostat was a source of danger, and it was also pointed out that the open section underneath the balloon was very favourable to the accumulation of gas. Senor Severo, however, adhered to his original plan, and had entire confidence in the safety of his balloon. The trials carried out on the grounds certainly showed that the inventor had not miscalculated the stability and easy manœuvring of his machine, for when held by ropes it was steered with the greatest facility, and there was an entire absence of any swaying movement. For a long time after the balloon was finished Severo was unable to make an ascent owing to the bad weather, but finding that the early mornings were relatively calm, he decided to make an attempt on May 12th. At five o'clock the balloon left the shed. Severo looked after the propelling motor, while Saché had charge of the front engine. The inventor had intended taking up one of his friends, but as it was found that the balloon was over-charged, this gentleman had to stand down at the last moment. As soon as it was released the balloon rose to a height of 1,200 to 1,500 feet. Severo was to have gone to Moulineaux, but the few

SENOR SEVERO IN HIS CAR.

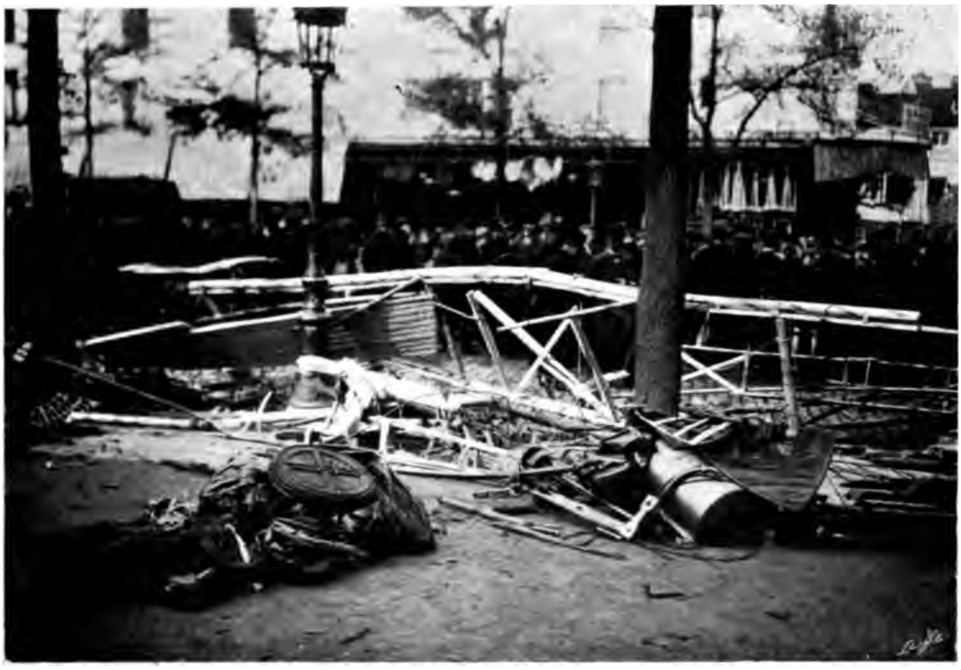
He appeared to be full of confidence and chatted lightly with his friends prior to ascending.

spectators on the grounds, among whom was Senora Severo, saw the balloon drift away in the opposite direction over Paris. The propeller was working very intermittently, sometimes giving a little headway to the balloon, and then stopping altogether. The balloon had evidently become entirely unmanageable. It had been up in the air about a quarter of an hour when a flame was seen to issue from the bottom of the balloon, and then to rise up like a cloud of fire. The heavy keel and framework fell, and at the same time a loud report was heard. Senora Severo dropped to the ground senseless, and the autocars which were in readiness to follow the balloon raced madly through the streets in search of the unfortunate aeronauts. The wreck was found lying across the Avenue du Maine. The unfortunate Severo was crushed, and the body of Saché was entirely carbonised, presenting a horrible appearance. Apparently, during the fall the tank in front had exploded, and Saché had become enveloped in the burning petrol, though both of them must have been dead before they reached the ground. As to the cause of the explosion, it is, of course, impossible to give anything more than the merest conjecture, and the most plausible explanation is that the gas escaping during its dilation at a high altitude must have been ignited by the motor, but precisely in what way will, of course, never be known. The petrol tank was apparently exploded by the heat. This is not the first catas-

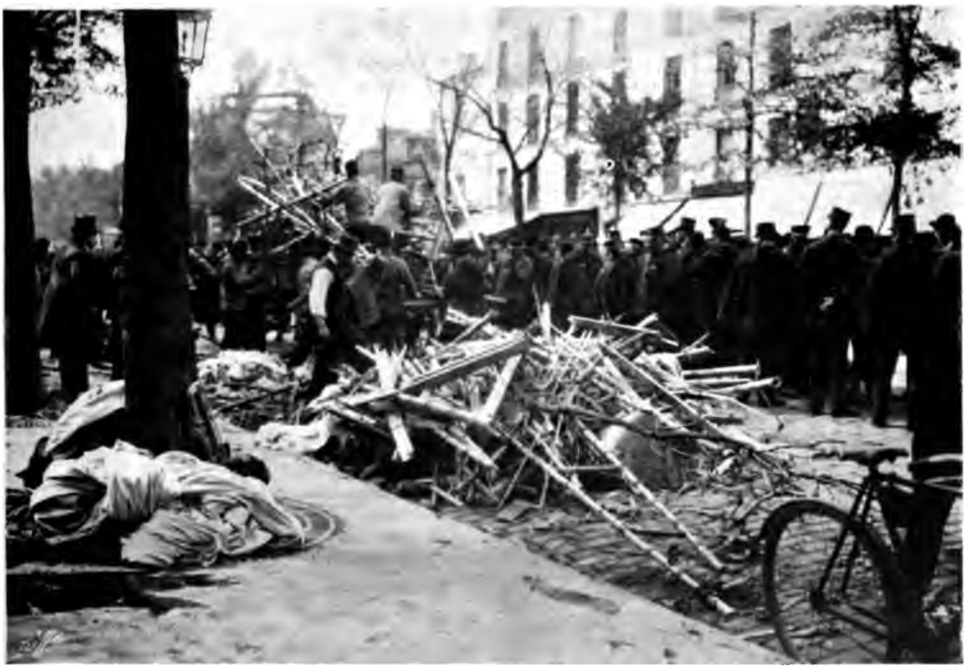


**GETTING READY TO START.**

The right-hand figure in the car is Severo.



THE DEBRIS OF THE "PAX."



CARRYING AWAY THE WRECKAGE.

trophe with a motor balloon, for on June 12th, 1897, an almost identical accident took place at Tempelhof, near Berlin, when Dr. Woelfert ascended in a balloon propelled by a petrol motor, and when at a height of about 2,500 feet there was an explosion, and the aeronaut and his assistant fell to the ground horribly mutilated and black with burns.

### SEVERO'S SACRIFICE.

Senor Severo had devoted his entire fortune to the construction of the "Pax." Had the balloon been a success he had intended returning to Brazil and raising funds for the building of a much larger one, and he confidently believed that he had solved the problem of practical balloon navigation. It is by no means certain even that his work has terminated with his death, for the Government of Brazil has sent an engineer to Paris to examine the remains of the balloon and report upon the advisability of its reconstruction. It may be taken for granted, however, that the lesson of the "Pax" will not be lost upon balloon constructors, who will scarcely attempt to incorporate the propelling mechanism in the aerostat unless some means be found of entirely isolating the motor from the gas. It has pointed out the existence of a danger which considerably narrows down the possibilities of motor balloons, and is turning attention more in the direction of flying machines.

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# The Bicycle as an Accessory to True Flight.

BY SIDNEY H. HOLLANDS AND G. LACY HILLIER.

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## PART I.—MAINLY RETROSPECTIVE.

MUCH has already been achieved in gliding flight, that is, with fixed sustaining surfaces and gravity as the only motor, from the period of Le Bris's later experiments, carried out in 1867 in France, but more particularly of recent years by subsequent experimenters. Thus Dr. Lilienthal, from 1894-7, may be said to have inaugurated a new departure, constituting the modern school of gliding and soaring flight. The system and apparatus adopted by Lilienthal's immediate successor and disciple, the late Percy S. Pilcher, in England, were a close imitation of those of Lilienthal, while those still in course of development by Octave Chanute, the brothers Wright, and Charles H. Lamson in America are variants, although differing considerably in design of apparatus. Mr. Lawrence Hargrave, of Sydney, N.S.W., has devoted a good deal of time and pains to the soaring branch of flight, but in his case with original apparatus and methods, using his now well-known cellular kites in large sizes, making ascents suspended from a series of these arranged tandemwise on one line; this, of course, under captive conditions, although the line is "paid out" as the kites rise, and the passenger is hauled aloft borne on the breeze, taking careful readings of the prevailing conditions meanwhile.

The latter five experimenters—level-headed, practical men and ardent workers in this comparatively unexplored field—are still devoting time, money, and their best energies to this *initiatory* and important branch of aviation. We say "initiatory" advisedly, as these workers are unanimous in the opinion—and rightly, we think—that motorless gliding or sailing flight should *precede* free flight by motor, and must form the preparatory or rudimentary course of experiment as it were, which is indispensable to an adequate understanding of the phenomena of the latter, and to a mastery of its many unlooked-for practical difficulties.

As Lilienthal aptly remarked in his celebrated article, "Weshalb ist es so schwierig das Fliegen zu erfinden?" ["Why is it so difficult to learn to fly?"] (original translation): "The method which is to lead to practical flight must be capable of development, be its beginnings ever so primitive, and by it we must be afforded an opportunity of really skimming through the air, by which we may gain experience as to the stability of flight, the action of the wind, and safe landing, in order—by continual development—to gradually approach permanent free flight. Perfection cannot be forced immediately. . . . Remaining in the air without a balloon, and free flight in it, are such a new sphere of action that it is necessary to *gradually* find one's bearings in it. . . . There are always new phenomena arising, and a single unlucky landing suffices to wreck the whole apparatus. . . . The means proposed, and put into practice by myself, viz., beginning with small flights and going on increasing them, are known to my readers. If I had at once begun by jumping into the air with 'wing-beats' (motor propulsion), the apparatus would then probably not have landed undestroyed. . . . Whichever method is pursued, progress can only be hoped for when the experiments facilitate an instructive observation of a really free flying body, for here there are entirely new phenomena not met with in other technical spheres."

Mr. Octave Chanute, of Chicago, speaking with reference to his air-gliding experiments—and they have been highly successful—said: "I am working to secure a machine which will be as steady in the air as a boat on the water. When I have produced an airship with this quality, *then* I shall endeavour to fit it with a motor to propel it. Most inventors in this line have sought to find a motor before having a ship to sail it in."

The method adopted to effect free gliding flight by the later experimenters—viz., Lilienthal, Chanute, and the brothers Wright—is, as is now generally known, that of taking a preliminary run, carrying the apparatus, that is, sustaining surfaces, against the prevailing breeze to the brow of a hill, and a short distance down the slope before launching off and becoming entirely air-borne, the apparatus then in turn carrying the man. The different method pursued by Mr. Lawrence Hargrave—and previously described herein—does not tend in quite the same direction as that of the others, in that—although very instructive and interesting—it does not afford a means of effecting *free* flight, but may, however, be said to be paving the way to it.

The system now to be dealt with, and advocated herein—a system involving the bicycle as an accessory to true flight or aviation—the "gliding" variety in the first stages, would obviously possess certain advantages not attendant on the foregoing systems. Thus, to mention the most obvious: the experimenter, instead of *carrying* the apparatus of sustentation while laboriously running along on the ground against a stiff head-wind—say a ten or twelve knot breeze—which is necessary to supplement his own tardy progress, hampered as he is, and to impart sufficient momentum for the launch off and subsequent "glide"—his weight would be carried by the bicycle, not only his own weight, but also that of the whole apparatus. In short, the rider and intending flier can concentrate his muscular energy on propulsion, instead of having to distribute it over propulsion plus carrying a considerable total load.

Then, again, with the smooth high speed attainable on a bicycle, the experimenter can be independent of natural winds, that is, he can, if he so desire, make trials in calm weather, making his own head-wind artificially in any direction that may be most convenient; while a very gentle down-grade will suffice for the preliminary run, if it is not even found practicable to get a rise from the level on a smooth, straight road after a smart spurt, and this is by no means improbable, given certain possible conditions.

Dr. Benjamin Ward Richardson, writing nineteen years ago in *Longman's Magazine* on "Cycling as an Intellectual Pursuit," incidentally makes several memorable remarks quite apposite to the subject of the present article. These far-seeing—probably prophetic—remarks are embodied in the two following paragraphs, which are quoted entire: "By the simple machines, bicycles and tricycles, we are returning to first principles. We are endowing every person who can use these machines with a new and independent gift of progression, and to what extent this art will proceed in a quarter of a century if it makes the same progress that it has made in the past twentieth part of a century, he were indeed a bold man who should venture to predict. I have already said what I now take occasion to repeat—that the art of flight will be the practical outcome of the grand experiment which is now going on; for, when a machine can be reduced in weight to 26 lbs., and when such a machine can be propelled on a good track twenty miles within the hour by human limbs, carrying the man who propels it, there are not many removes to the capacity of driving wings or air-screws at a sufficient rate to afford support to the machine on the air. I think that many persons will indeed live to see a partial development, at least, of this kind. They will, I mean, see constructed a machine which will be partly sustained by the air and partly by surface of water—of sea, or lake, or river—and which will skim over such surface with just sufficient friction for steering power, and no more. In short, a flying canoe or boat, which, elegant as useful, will at one moment like a nautilus run with the wind, and at another skim the water, independently of wind, like a sea-bird.

"As we stand at present, we have, then, to recognise two facts: one an accomplished fact, namely, that men and women can do such remarkable feats in progression that they are now the swiftest and most enduring of all land animals; and the other a promising fact, namely, that men and women may soon rival animals of the sea and of the air in the same process. The facts suggest that the time has come when an enquiry is demanded on the questions whether we are now employing what has been done to the best of purposes, and whether the future outlook is in every sense satisfactory. It appears to me, as one of those who take part in the development of a great movement, that the best is not being done, and that a new departure is immediately demanded in order to keep the progress of the art of cycling in a proper position in respect to its advancement and its usefulness."

In the foregoing remarks Dr. Richardson evidently contemplated the application of some form of air-propeller—either wings or screw—to the bicycle *at the outset*, attendant on the first step in its adoption as a means of flight; but as he of course writes only as a layman in touching on this application of the machine, and, moreover, before the era of the gliding flight experimenters of recent years, this can be understood and duly allowed for.

However, as hereinbefore stated, we are now advocating the use of the bicycle, plus suitable sustaining surfaces used in conjunction with it, as means of mastering the preliminary difficulties attendant on free flight, being impressed with its peculiar adaptability to this purpose.

With a view to attaining a minimum of weight, and a maximum of simplicity of apparatus in the initiatory stage, we propose the use of the simple racing safety bicycle, propelled in the ordinary way by its rider. When this stage has been passed through satisfactorily, and when the experimenter feels himself to be intimately acquainted with the behaviour and management of his apparatus under all conditions likely to be encountered on trial, it will then be in order to consider the application of a motor other than man power. The existing types of motor bicycle, moreover, are scarcely adapted for this special application—that is, as regards the mechanism for transmission of the power. A modification—and an important one—will need to be effected in this feature, due to the fact that *sustained flight* will then be aimed at, which is not contemplated in the earlier stage of experiment.

When the motor bicycle comes to be employed as the nucleus, as it were, of an aerial machine, its motor must be so designed and connected as to concentrate its power, when air borne, on air-propelling media.

*(To be continued.)*

## An Early Flying Machine.

The art of ballooning is actually little more than a hundred years old, but it is worth while quoting a description of a Brazilian flying machine which was constructed early in the eighteenth century. The ship was scallop-wise at both ends, and had sails which turned as they were directed. There were two wings to keep it upright, and a rudder to govern it. In the body, at each end, were a pair of bellows to be blown when there was no wind, and two globes of metal to cover two loadstones to draw the ship after them. The body was of thin iron plates, covered in straw mats, for ten or twelve men besides the constructor. Above the body was a network of iron wire, on which were fastened large amber beads, "which, by secret operation, would help to keep the ship aloft; also by the sun's heat the mats that lined the ship would be drawn to the amber beads." It is difficult to see why the monk who invented this extraordinary machine should have been put to death as a sorcerer. If it had managed to move about in the air, there would have been more justice in the sentence which was carried out.

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Major Baden F. S. Baden-Powell, of the Scots Guards, is forty-two years of age. He is a younger brother of the defender of Mafeking, and, like him, has done useful work in the recent war, having been in a number of the earlier engagements. He is the inventor of the man-lifting kite, and has made many ascents by that kind of flying machine. The present British war balloon also owes a good deal to his experiments, and he was for some years president of the Aeronautical Society. Another invention of his is the tripartite bicycle.

# Dr. Barton's Airship.

AT the Aeronautical Institute and Club meeting on Friday, April 4th, a paper was read by Dr. Barton, in which he described his airship. He said:

After experimenting over nineteen years, that is, from November, 1883, with a navigable balloon similar in every respect to that of Santos-Dumont's at the present time, I then went on to try aerodomes on machines composed entirely of aeroplanes. The first series of experiments proved that the cigar-shaped balloon could be steered horizontally, but that it had the following drawbacks: First, that it could not be steered forward without letting out gas, and therefore ballast, which greatly curtailed the usefulness of the balloon, inasmuch as its time in the air was limited. Secondly, there was danger of its tilting if the balloon was improperly filled, in which case the propeller would come in contact with the rudder or suspending lines, and so break up the whole machine. Thirdly, that the suspended weight of the trail rope was a source of danger, as it was liable to catch on objects on the ground.

DR. F. A. BARTON.

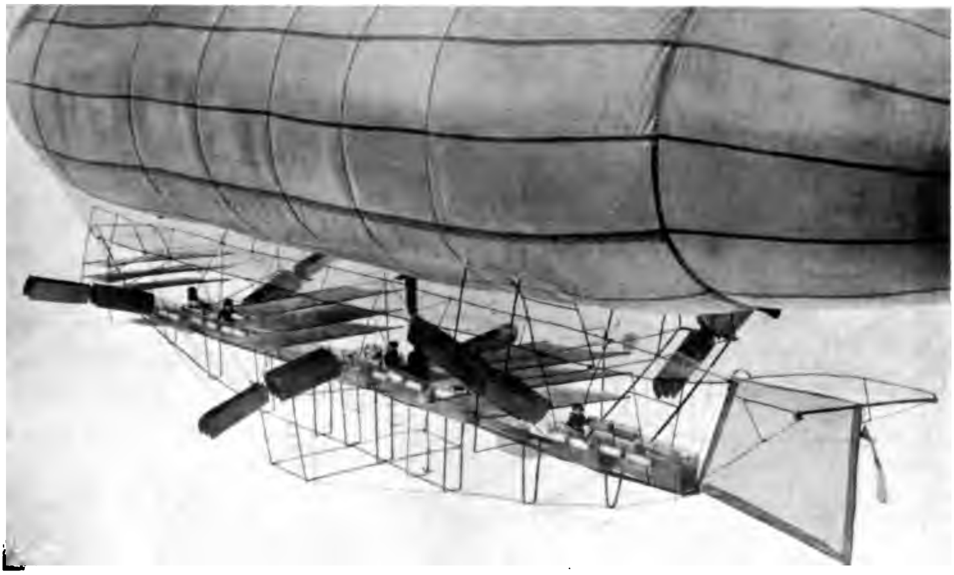
In regard to the second series of experiments—that is, on aeroplanes. These are ideal machines, for which we are all searching, because they are capable of very rapid transit through the air. The chief drawback is their great want of stability and the danger if anything should happen to the motors to stop the propulsive power.

In 1898 I combined the two methods by interposing an aeroplane system between the car and a cigar-shaped balloon. On this aeroplane frame I have arranged a series of multiple aeroplanes, and from the experiments I have made with models at different times I have had most satisfactory results.

The balloon which I am about to build by the order of the War Office can be put to the following uses: For military scouting, reconnoitring, surveying to prevent ambushes, to locate enemy's position by night, to prevent night surprises, etc., and, with large machines, to convey stores and take back wounded. The balloon is 180 feet long, of Japanese silk. The maximum diameter is 41 feet; greatest diameter two-fifth from the bows. It contains 156,000 cubic feet; the interior balloonet holds 12,000 cubic feet of air, or net capacity 144,000 cubic feet, or a lifting effect of 10,080 lbs. It is divided into three compartments—fore and aft tapering ends and central—with valve connections. There is a secret contrivance by which the aeronaut can regulate the amount of gas in each compartment.

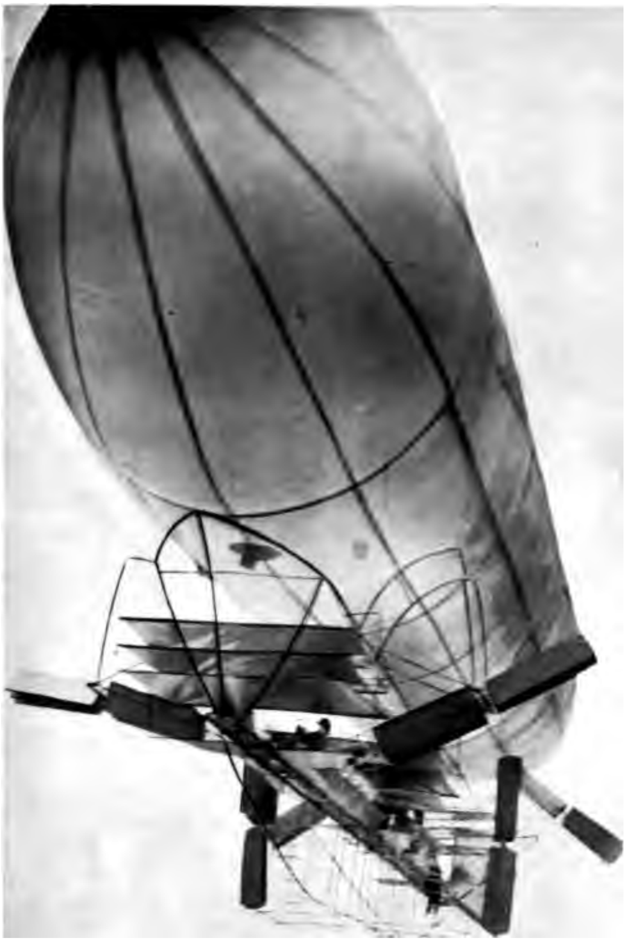
A chemise covering is used, in the edge of which are sewn thin strips of bamboo, bound together so as to form one long suspending rod, to which are attached the cords which run down to the aeroplane frames.

The advantages of this chemise are that it gives almost a double skin to the balloon, preventing leakage to a great extent. The balloon, being punctured, say, by a bullet, contracts owing to loss of gas, and thus the holes in the balloon fabric and chemise no longer tally, and, consequently, the balloon can be said to be self-sealing. The aeroplane frame will be 120 feet long, and composed of tubular steel. Attached to this aeroplane frame will be three sets of treble horizontal aeroplanes, fixed upon the anterior transverse bar, but movable up and down on the posterior, in an arc, the centre of which is posterior to the anterior transverse bar. These, when perfectly hori-



A MODEL OF DR. BARTON'S AIRSHIP.

zontal, will form aeroplanes with no friction practically. When raised or lowered they form aerocurves. The total surface of the aeroplanes amounts to 1,944 square feet; they are each 12 feet long and 18 feet wide, and composed of oil silk.



**ANOTHER VIEW OF THE MODEL.**

The posterior vertical aeroplane or rudder requires no description, as it is identical in its action with the rudder of a ship.

Regarding the work of the horizontal aeroplanes, Mr. Walker has found by experiment that the aeroplanes fixed against a wind blowing at a speed of twenty miles an hour will give a lifting power of 2 lbs. to the square foot; even allowing ½ lb. to the square foot, the surfaces as arranged will provide a depressing effect (if required) of 972 lbs., which is equivalent to letting out 14,000 cubic feet of gas.

The propellers are six in number; three on each side in different planes. They are two-bladed and trebled, and arranged on the "Mangon" type. Each pair of propellers is worked by a 45 h.p. Buchet petroleum engine.

The water balance arrangements are simple, and likely to be most effective. Two tanks, capable of holding some fifty gallons of water each, are fitted at either end, and connected with pipes. They are half filled, and the water is automatically pumped from one end to the other by a small single-acting motor, the valves of which are opened and closed by means of a pendulum device.

The whole upper surface of the aeroplane frames is covered with a fine cotton gauze, and the propellers are enclosed in separate framework, which arrangements will make it quite impossible for the balloon car to come in contact with the propellers, which otherwise there might be a chance of their doing when the balloon comes to earth.

Two hundred and sixteen gallons of petrol are carried in thirty-six tanks, arranged along the side, and it is calculated they will provide power to allow the balloon to make a journey of twenty-four hours' duration, or a distance in calm weather of from London to Edinburgh.

In the debate following, Mr. E. T. Gratzes enquired whether Dr. Barton had taken into his calculations the chances of coming down into the water.

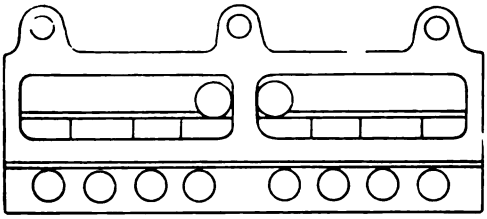
Mr. C. H. M. A. Alderson did not think the system of tripling the propeller blades would prove to be advantageous. He advocated the simple double-bladed propeller, and described experiments.

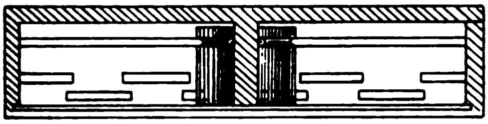
Mr. H. E. Holtorp considered that the design of framework of balloon did not lend itself to safe landing. In his opinion it should be strengthened at the base.

Mr. R. McNair expressed himself as very much in favour of the whole design as exhibited in the model before the meeting, and of which we give two illustrations.

# Walker's Equilibrium Regulator.

MR. FREDERICK WALKER, of Oxford, has designed an automatic and anticipatory equilibrium regulator for preserving the stability of electrically-driven airships. This regulator is shown in front elevation and section below. It consists of an insulating case divided into two compartments, each having a heavy bronze roller, rolling by gravity over contact surfaces. The back strips are connected to the main lead, and are higher than the other strips, so as to engage with an annular groove in each roller to guide it. The other strips are connected to the terminals of a rheostat, which is cut out of both branch motor circuits when the airship is level transversely.





The twin screw-propellers rotate under triple aerocurves, and the action of the regulator is to diminish the speed of the motor on the lowest side by putting resistance in. The longitudinal equilibrium is controlled by a similar regulator set fore and aft. This acts by reversing a small electro motor, which alters the angle of a long tube centrally pivoted, containing about 60 lbs. of mercury. This regulator is specially designed for the new airship "Spezia," which is being built to the order of M. Panuzzi, and is the second British airship in construction, and the first to be driven by electricity. The power plant is designed by Mr. Frederick Walker.

## A New Motor.

Mr. William Ede, who recently landed in this country from America, has designed a new motor for the propulsion of aerial machines. It is an application of existing principles in a very simple and light form. A 25 h.p. motor built on his design will not weigh more than 30 lbs. or less than 1¼ lbs. per horse-power. Aluminium is largely used in its construction, and it possesses two light steel cylinders, which give "a double explosion." Interesting, but vague.

# Motor Aviation of To-day and of Recent Years.

### By SIDNEY H. HOLLANDS.

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(*Continued from page 61.*)

## On Aerial Stability.

The condition of stability in all air-borne vehicles is sufficiently important to warrant a separate article being devoted to it, more particularly as it is not generally given due consideration and provision in the designing and construction of aerial apparatus.

The absence of even a moderate degree of stability has accounted for numerous failures and some fatalities in otherwise promising experimental machines, and therefore the attainment (equipoise) is a great desideratum in all schemes of aviation.

The attainment of this very essential quality has been a remarkably hard nut to crack, more particularly as longitudinal and transverse instability have had to be battled with separately and conquered by different means.

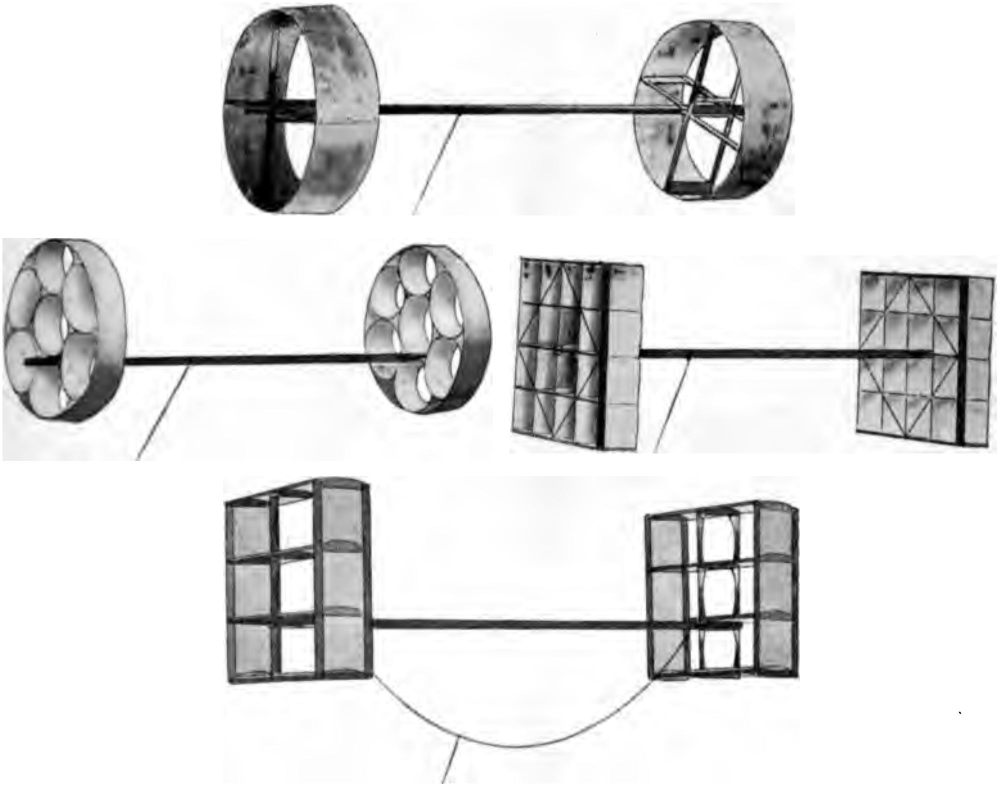
Dr. Lilienthal truly remarked in his article previously quoted, that "stable free flight, in spite of the irregularities of the wind, and safe landing are factors about which we have very little practical experience, but of which the practice of technical flight consists, but this circumstance by no means renders the complete solution of the problem impossible, but only the more difficult." The foregoing was written in 1894.

Mr. Chanute wrote in 1890: "The problem of the maintenance of the equilibrium is now, in my judgment, the most important and difficult of those remaining to be solved." The remarks of the foregoing authorities are apposite and noteworthy, but in both cases they were written some years ago—seven and eleven years ago respectively. Now we have certainly learned and achieved something in aerial stability since then, having now the very valuable means to that end devised and practically experimented with by Prof. Langley and by Mr. Lawrence Hargrave. The latter gentleman has paid very particular attention to this vital question, and in his "cellular kite" system he has happily applied a very efficient principle, and contributed a very valuable means to the attainment of stability in air-borne vehicles.

The general form of the Hargrave "cellular kite" is probably now known to many readers as the "box kite"—its simplest form (see illustrations). The compound forms, however, of which Mr. Hargrave has designed and tried a considerable variety (see illustrations), consist of two sets or groups of parallel and adjoining open cells, generally of rectangular form, each separate and detached set constituting a sort of deep chequered grating. These two sets of cells or frames are fixed at opposite ends of and at right angles to a light bar or stick, which separates them rather widely, to which stick the string is attached near the middle. In the simple "box kite" four parallel sticks connect the two single cells at ends.

The extraordinary degree of stability inherent in this system is seemingly mainly due to the two sets of cells being detached and spaced some distance apart in parallel planes, but rigidly connected, the connecting stick or sticks lying almost horizontally when the kite is "flying."

Mr. Hargrave claims for this system, and doubtless with good reason, "perfect stability" and "wide limits for the distribution of weights," both of which are very desirable qualities. It is the adequate provision for longitudinal stability that is the more difficult and that gives the greater trouble, that is, to counteract the tendency to pitch and toss, with perhaps finally a back somersault. It is this most perilous tendency that Mr. Hargrave's "cellular kite" system, or analogous systems of detached sustaining surface, so admirably counteract. In an aerial machine this evil apparently could be cured by erecting one of these cellular frames (really a set of superposed planes bounded by and enclosed between vertical side planes of equal depth longitudinally) at each end of the machine.



DIFFERENT TYPES OF HARGRAVE'S CELLULAR KITES.

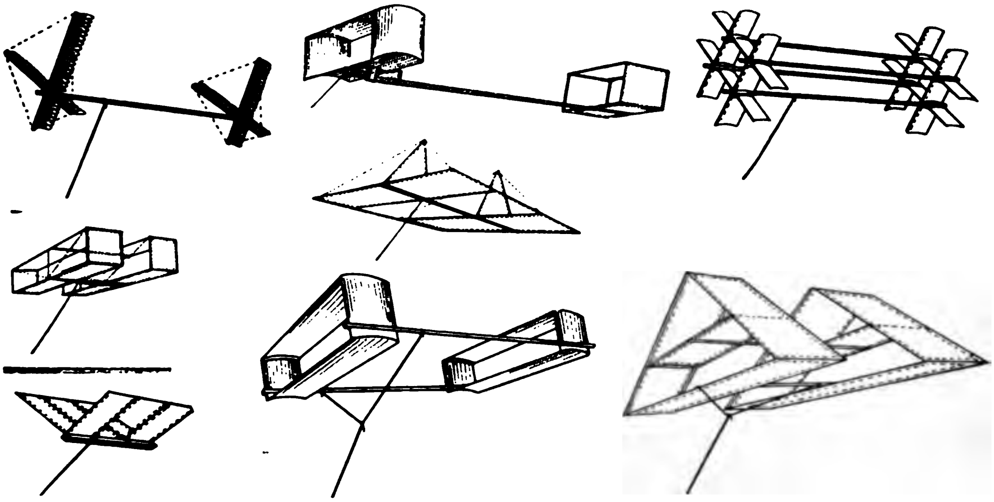
To some extent Mr. Hargrave's system provides transverse as well as longitudinal stability, but for large, practicable aerial machines carrying distributed weight other provision (described later on) will be made for transverse stability.

In the large Maxim machine longitudinal stability was to be attained by arranging to tilt or swing the fore and aft horizontal rudder planes at opposite angles to the main aeroplane, so that when thus tilted and the machine pitching the rudder plane at the depressed end of the machine would for the time have the greater sustaining and checking effect. This arrangement, however, did not provide *automatic* stability, and the latter condition is imperative.

It is true that Mr. Maxim designed and purposed using some ingeniously-devised apparatus, comprising a gyroscopically-controlled - relay - fluid - pressure auxiliary motor (a long-stroke steam cylinder with direct connection) operated through a "relay," by a gyroscope that was driven by a small steam turbine, and intended to work the horizontal rudders automatically.

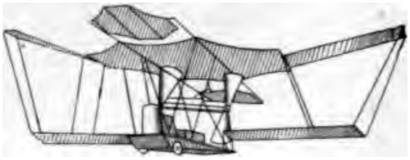
This apparatus was far more complex than is admissible in any really reliable self-righting system.

It may be laid down as a general principle that no system or appliance to render an aerial machine automatically stable must involve any moving parts, but must consist in a suitable formation and arrangement of the *fixed* sustaining surfaces.



SOME MORE FORMS OF HARGRAVE'S CELLULAR KITES.

With a view to transverse stability or counteraction of the rolling tendency, the Maxim machine was fitted with transversely-inclined and superposed wing planes on each side, springing from the sides of the main aeroplane and the sides of the platform below at an upward and outward angle (see illustration). These were better than the longitudinal provision, in that they were permanently fixed, but probably would, however, have been found inadequate in free flight owing to position and being disproportionately narrow in relation to main aeroplane.



Maxim's Machine—Final Type.

C. B. Mansfield, M.A., in his book "Aerial Navigation" (1877), advocates the use of a small pendulum, which releases alternately two sets of wound-up spring-driven mechanism (or other stored energy), shifting a movable weight in the car in the required direction to restore the balance of the vehicle when it began to either pitch or roll, the appliance being of the nature of a "relay."

A modification of the last-named system

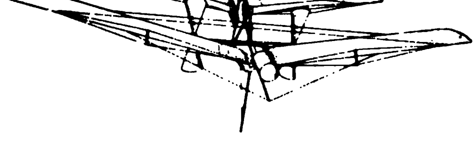
has since been advocated by Thomas Moy, his pendulum being inverted, though it is not clear what advantage would be gained by that.

These systems, though ingeniously conceived, are really inadmissible, being even impracticable as a trustworthy provision for the same reason as that of Maxim and all analogous systems involving shifting weights or other moving parts.

It will doubtless be urged by some that in the recent Santos-Dumont "air-ship" evolutions moving weights were successfully used in the "car" (or its equivalent lattice girder). In anticipation of such argument, I will content myself with remarking that I am treating of true flying vehicles, the inevitable and ultimate gravity systems only, and recognise no form of balloon as a "flyng machine."

Lancaster in his "sailing effigies used an adjustable pendulum, as did also Hargrave in his "aspirating" model, to impart stability, but these when once adjusted to the true position (found by repeated trial) were then fixed so permanently. (See illustrations.)

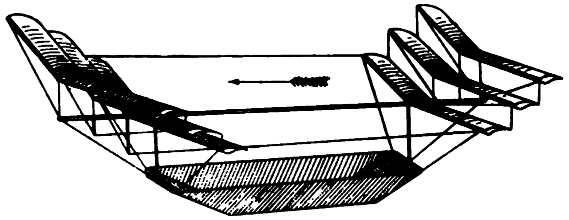
Prof. Langley's "Aerodrome" presents an ideal system of stabilty, as practical results have, moreover, abundantly proved (see illustration in previous issue). There we have the fixed-wing sustaining surfaces detached longitudinally (with a suitable interspace) for longitudinal stability, and we have those surfaces set and fixed at a "diedral" angle (each at an angle of 75° with the vertical centre line transversely), giving efficient provision for transverse stability. It is automatic and invariable in both directions with extreme simplicity.



**Professor Langley's "Aerodrome"—*Second Successful Type.***

The author may perhaps be excused alluding here to a system of sustaining surfaces of his own, designed with a special view to stability. Although on analogous lines to those of Prof. Langley, it was designed by him long before the "Aerodrome" was produced or description of any of Prof. Langley's apparatus published.

The system alluded to is that involving an arrangement of "stepped" and transversely sloped aerocurve sustaining surfaces (see illustration), for which the author claims specially good sustentation (for a given surface) as well as stability.



**Duplex arrangement of STEPPED Aerocurves.**

**Either wing or screw propulsion may be used, and the number of steps is not restricted to three (the writer claims entire originality for this system).**

Drzewicki, a Russian engineer and a good authority, said: "The law of longitudinal stability consists in placing the centre of gravity of the whole apparatus vertically below the centre of pressure (of sustaining surface) due to the angle of flight, and also that these two centres of gravity and pressure respectively must be but a very short distance apart in order to prevent oscillation." It is questionable, however, whether this law is applicable to other than very acute angles of the sustaining surface with the plane of motion.

*(To be continued.)*

# International Commission on Aeronautics.

AT the meeting of the Aeronautical Institute and Club on June 6th, Mr. James F. Carter, A.I.E.E., of Bath, who represented the Institute, presented the following report of his visit to the International Commission on Aeronautics and Meteorology, which was held at Berlin from May 19th to 25th, and which was opened in the Imperial Reichstag by H.R.H. Prince Frederick Henry of Prussia, who represented the Emperor:

Professor Hergesell occupied the chair, and amongst the delegates present were Messrs. Cailetet (Paris), H. Kusteznow (St. Petersburg), Pallazzo (Rome), Rotch (Boston), Rycatschew (St. Petersburg), Valentin (Vienna), Ebert (Munich), Tieserenc de Bort (Paris), Schotter (Vienna), Alexander (England), Köppen (Hamburg), Bruce (London), De Fonville (Paris), Vives y Vich (Madrid), Assman (Berlin), Berson (Berlin), Linke (Potsdam), Suring (Berlin), Von Berzold (Berlin), Hinterstoisse (Austria), Trollope (England), Covanco (Russia), Borgatti (Italy), Unge (Sweden), Kowano (Japan), Emden (Munich), Kress (Vienna), Hofman (Berlin), and Hutchinson (Cambridge). Besides some of the principal scientists and savants of the civilised world.

On May 20th a discussion took place on the landing of balloons in a foreign country, and on the necessity for the establishment of rules and regulations in regard to the same, and also in regard to the finding of *ballon sondes* and apparatus landing in another country. The publication of the official organ of the commission was also discussed.

On May 21st (morning) General Rycatschew read a paper on "Preliminary results of observations made in Russia with kites, *ballon sondes*, and manned balloons within the last five years." M. Tieserenc de Bort a paper "On the decrease of temperature in the higher regions, from records of 258 *ballon sondes*, having gone above eleven kilometres high." Herr Pallazzo (Rome) papers on "The part taken by the Italians in the scientific investigations of the upper atmosphere" and "The fitting out of the new observatory for physics of the atmosphere on Monte Poro." M. Violle (Paris) paper "On the solar radiation and its measurement in a balloon." H. Von Berzold (Berlin) "On the stratification of the atmosphere." In the afternoon papers were also read by Professor Assman (Berlin) "On the employment of rubber balloons"; M. Tieserenc de Bort (Paris) "On the isolation of the thermometer in self-registering instruments"; H. Valentin (Vienna) "On the sluggishness of the curve of the thermometer in self-registering instruments"; H. Hergesell (Strasburg) "On the application of a special sensitive thermometer and its results"; Vives y Vich (Madrid) "Description of a statoscope of M. Le Capilan Royas"; Mr. Alexander (Bath, England) "On steering flying machines or navigable balloons by Hertzian waves"; Mr. E. S. Bruce (London) "Metearo parachute."

On May 22nd a visit was paid to the aeronautic observatory outside Berlin. Three of the indiarubber *ballon sondes* were sent away with instruments for registering the barometric pressure, humidity, temperature, etc. The great advantage of this type is that the balloon is filled with hydrogen and the mouth sealed; it is then capable of expanding to three times its diameter. A thinner piece of rubber is inserted in the top, which bursts, and so lets the gas out gradually. These frequently reach a height of from twelve to fourteen miles. The arrangements for kite flying at the observatory are very complete. A lofty tower is used. The kites are first flown from a small winch on the ground, and then the wire is taken by a traveller to the top of the tower and connected to the winding engine at the base by suitable fair-leads, and also runs through a dynamometer, which gives at any time the pull. It is then passed several times over large grooved pulleys, and then to the drum of the engine. Five or six miles of wire are frequently used. A very interesting event happened during the afternoon. Two box kites were being flown side by side, and probably one mile vertical, one wire being used, and the two kites joined to it by their own hempen strings. The weather was rather dull. Suddenly one kite was seen to fall, and on recovery it was found that the string was completely burnt through. The kite must have accumulated a large charge of electricity on its surface, and not being able to discharge but through the string, probably found a dry part of much higher resistance in its passage to earth, and so burnt it. When wire is used it is advisable to earth the home end, or very serious shocks may be experienced.

In the afternoon (May 22nd) Mr. Rotch (Boston, U.S.A.) read a paper on "Fathoming the atmosphere over the ocean," and H. Berson (Berlin) a paper "Concerning a plan of a meteorological kite expedition to sub-tropical and tropical regions." The governments of suitable regions are, it is understood, to be approached with this object in view, and very useful and interesting results are anticipated. H. Köppen (Hamburg) read a paper on "Kite experiments in Hamburg;" H. Kusteznow (St. Petersburg) "On an apparatus for registering the pressure of the wind carried on kites;" Tieserenc de Bort (Paris) "On the utility of frequent aerial sounding, with first results of same, carried out at Trappes." This gentleman, at his private observatory outside Paris, sends away a large number of *ballon sondes* with registering instruments, and also conducts a large number of kite experiments. Prof. Hergesell paper on "Kite stations on mountains;" Mr. Bruce "On the international kite competition which is to take place under the auspices of the Aeronautical Society of Great Britain."

On May 23rd the members of the commission visited the German military ballooning establishment, and were shown over what is probably the finest establishment of the sort in the world. The officers' and men's quarters were inspected, and the visitors seemed much struck with the intelligent manner in which everything is arranged for their comfort. The large balloon hall or shed was next visited. This immense building, about 100 metres long by 24 wide and 20 high, is capable of holding several large balloons completely inflated and ready for flight. The immense doors can be opened by one man in a very short time, and the detachment marched out and the free balloons sent off in a few minutes. Three free balloons of about eight hundred metres capacity were sent away during the day, carrying three to five passengers. The last balloon, which was in the air for several hours, and travelled about fifty miles, contained gentlemen of five nationalities. In the German military free balloons there is a very small valve; no anchor is used. A portion of one of the gores at its upper part is stuck with cement to the inside of the balloon, and its upper part fitted with a becket, to which is attached the valve or tearing line. A trail rope is used; on nearing the ground in a suitable place the line is pulled and the strip torn off, and the gas is very soon gone. The advantages of this form of getting rid of the gas need not be remarked on, except to say it is very quick. The sending up of a captive or kite balloon was very instructive and interesting. The waggons were galloped on to the field, the balloon unpacked, opened out, charged, sent up five hundred feet, and a telephonic message received in less than fifteen minutes, which, considering that the capacity of the balloon was about eight hundred cubic metres of hydrogen, was a very smart performance. The captive was then disconnected from the winding waggon, and the detachment marched away with it as if retiring. Signal balloons were also sent up. The electric light and power station is on the premises; also pumping arrangements for taking hydrogen from one balloon to another. The photographic arrangements are very complete, and everything is brought to a high state of efficiency. The entertainment of the members of the commission by the officers of the balloon battalion was hospitality itself.

On May 23rd (afternoon) M. Cailetet (Paris) read a paper "On an apparatus for breathing oxygen at high altitudes;" H. Suring (Berlin) a paper "Concerning the high journey of 31st July, when a height of 10,000 metres was reached by Messrs. Berson and Suring, of Berlin;" H. Von Schotter (Vienna) "Concerning the physiology of high balloon ascents."

May 24th. H. Ebert (Munich) a paper "On the direct measurement of electricity in the atmosphere from a free balloon." H. Linke (Potsdam) on the same subject.

On Sunday a visit was paid to the Government observatory at Potsdam, which is comparatively new and up to date. Among the many things of interest was shown a siesmic record, taken at Potsdam at the time of the eruption at St. Pierre, in the West Indies.

In conclusion Mr. Carter said: "I cannot speak too highly of the hospitable manner in which we were treated by the German people—military, official, and private; and also of the magnitude of the work being carried out by the International Commission on Aeronautics and Meteorology."

The President (Dr. Barton) proposed a vote of thanks to Mr. Carter for his interesting report, and in regard to the landing of balloons in foreign countries he said it was abominable the way in which aeronauts were treated by the police in foreign countries. They were arrested, and all their papers and photographs were destroyed. In Russia it was very bad indeed, and he hoped good results would follow the deliberations of the Commission.

Mr. Field seconded the vote of thanks, and it was carried unanimously.

## A Balloon in a Whirlwind.

Two aeronauts, Lieutenant Hildebrande and Professor Mieter, who recently made a balloon ascent from Rheineckendorf, met with a terrible adventure. Their balloon was carried upward by a current in a low-lying storm cloud, and it was then buffeted about. The occupants had to hold on to the basket, for it was several times whirled up into the air higher than the lower part of the balloon. Added to this there came rain, snow, and hail. The gas, meanwhile, was rapidly leaving the balloon. The balloon began to fall at the rate of at least thirty feet a second from a height of 6,000 feet, but, fortunately, the aeronauts were saved through their balloon falling upon a thick growth of brushwood.

# The Aero Club.

AT the Ranelagh Club on Saturday, May 31st, no less than three balloons — the "Graphic," capacity 45,000 cubic feet, belonging to Mr. Frank Butler; the "Vivienne," capacity 35,000 cubic feet, the property of Mr. Leslie Bucknall; and the "Shropshire," capacity 35,000 cubic feet, owned by Sir Vincent or Kennett-Barrington —ascended from the picturesque grounds of the Ranelagh Club at Barnes Elms, to the delight of a numerous and fashionable assemblage. Sir Vincent was accompanied by P. Spencer and Mr. S. F. Edge, who was making his maiden ascent, Mr. Butler having the company of that skilled automobiliste and intrepid aeronautiste, Miss Vera Butler, Mr. Jno. Holder, and Mr. C. F. Pollock, while in Mr. Bucknall's balloon were Mr. Leslie Bucknall and S. Spencer. Mr. Butler's handsome aerostat was away sharp to time (3.30), and rising rapidly above the trees, took a north-westerly direction. The "Vivienne" followed some ten minutes later, but kept a few more points to the westward, and after about half an hour appeared to have risen to a great height in the north western heavens. Mr. Bucknall was quickly followed by the "Shropshire," which appeared to sail a middle course between the two, rather following the "Graphic." After delightful cruises, the "Shropshire" descended at Godington, near Bicester, the "Graphic" (which made the longest flight) near Evesham, and the "Vivienne" near Warwick.

MAKING READY AT THE GROUNDS ADJOINING THE RANELAGH CLUB.

# M. Santos-Dumont's Airship.

A TOTALLY unexpected mishap to the balloon of the airship in which M. Santos-Dumont had arranged to make ascents from the Crystal Palace Grounds early in June prevented the young Brazilian from carrying out his demonstrations. The aerial machine had been exhibited at the Crystal Palace, where it was viewed by thousands of people. In fact, Englishmen have, like the French, caught the aeronautical fever, and M. Santos-Dumont's proposed experiments have created the liveliest interest. A commodious shed having been erected in the grounds, the balloon was removed by competent hands to the new quarters, where it remained in charge of M. Santos-Dumont's two assistants until the aeronaut came to inspect it. Alas! when Dumont did arrive he discovered several serious rents in the skin of the balloon. He was terribly distressed at the discovery, and in his excitement he attributed the damage as the work of some malicious persons. Subsequent expert inquiry, however, has discredited this, and it is thought that the slits were probably caused by the clumsy manner in which the skin was folded and packed, and it is not unlikely that the material had from various causes deteriorated. The Army Balloon authorities are also inclined to the view that the silk had perished, and it was further suggested that the deterioration had been caused by the immersion of the balloon in the Bay of Monaco, by its inflation with atmospheric air after hydrogen had been used, and by the heat from the glass of the Crystal Palace roof, near which it had been hanging. It is satisfactory to know that the authorities and M. Santos-Dumont himself have now abandoned the idea that the injury was wilfully done; and in view of the opinion that the silk had "perished," and of the terrible results of a mishap which might have been caused by defective material, it cannot be said that the accident is an unfortunate one.

M. Santos-Dumont has indefinitely abandoned his airship flights in England, and left recently for Paris to superintend the building of his new ship, which is to replace the one destroyed at the Crystal Palace. There is a possibility that M. Santos-Dumont will fly in this country next summer, and the shed which has been built at the Crystal Palace for his destroyed ship will remain for his use should he require it. M. Santos-Dumont will return to London to witness the Coronation, after which he sails for America.

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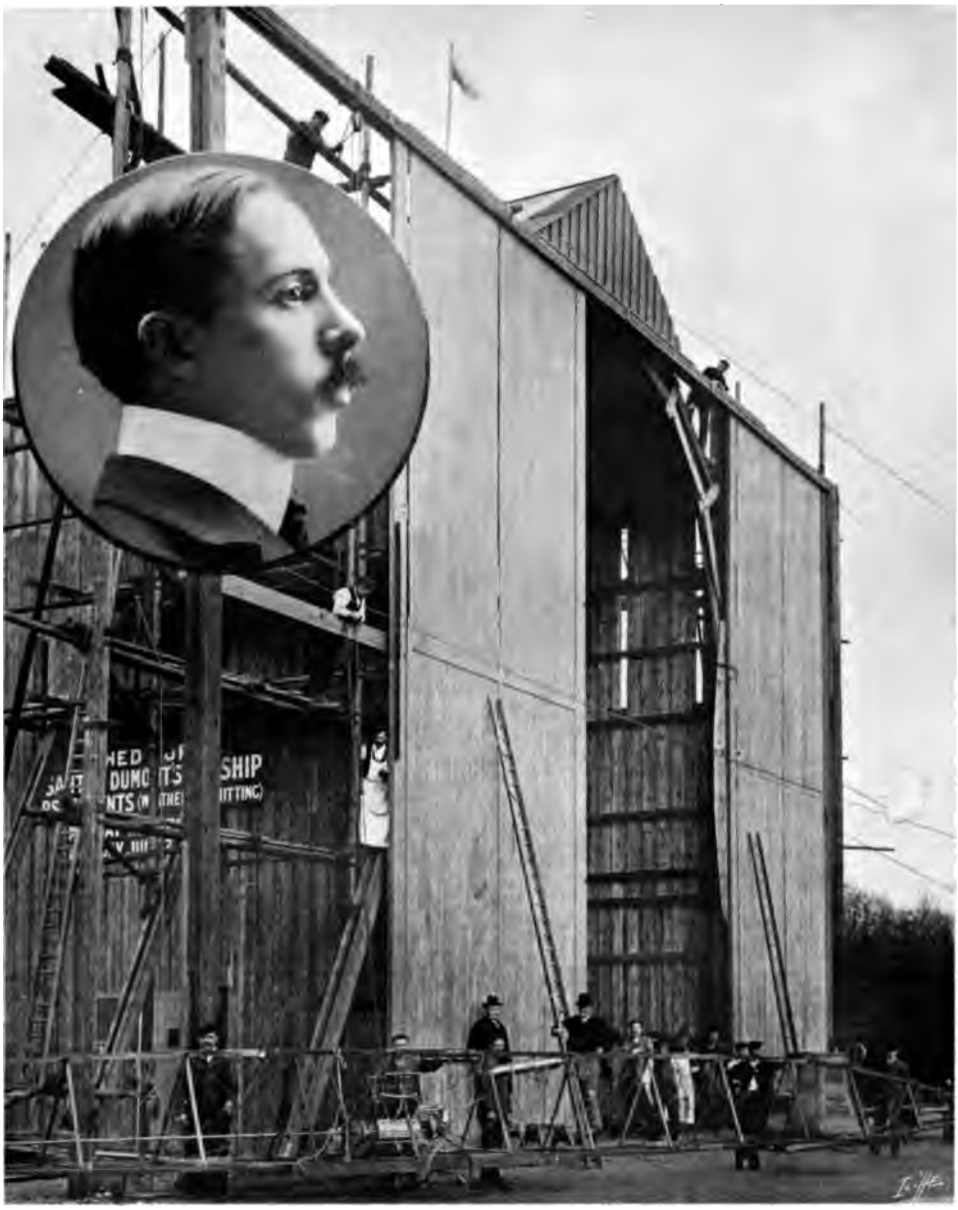
Mr. James Glaisher, the famous meteorologist and aeronaut, celebrated his ninety-third birthday in April. In one of his twenty-eight scientific balloon ascents, in which he was accompanied by Mr. Coxwell, the extraordinary height of over seven miles was attained. Mr. Glaisher founded the Royal Meteorological Society in 1850.

Mr. F. R. Simms's flying machine comprises a velocipede frame, carrying a motor in the usual position, but geared to propellers carried at the end of a shaft at the back of the frame. A series of aeroplanes are supported above the cycle by rods and ties, the ties being utilised to control the angle of the aeroplane.

## THE SANTOS-DUMONT AIRSHIP.



**The shed which was erected at the Crystal Palace for Santos-Dumont's airship just prior to the accident referred to on the opposite page. The motor and keel belonging to the balloon will be noticed in the foreground.**

THE AERO CLUB MEET AT THE GROUNDS OF THE RANELAGH CLUB.
(See page 123.)
Mr. Leslie Bucknall's "Vivienne" ascending.

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## Successful Experiments.

A most successful series of experiments has just been concluded at Toulon, with a view of testing the efficacy of balloons for locating the whereabouts of submarines. The outcome is distinctly to the advantage of the balloon, the aeronauts in every instance succeeding in detecting the submarines and telephoning the discovery to the destroyer to which the balloon was attached. The submarines have been painted hitherto a sea-green. They are now to be painted other colours in order to ascertain which colour renders them least visible from the balloons.

## A Strange Incident.

The new navigable balloon constructed by MM. Lassagne and Thibaut, with which experiments have been made in Paris, is propelled by a motor of 30 h.p. The balloon itself is over eighty feet in length. On one occasion a bystander, considering the weather too dangerous for a trial ascent, cut the cord of the escape valve, with the object of liberating the gas. One of the inventors sprang at the valve, and attempted to stop the deflation, when a gust struck the balloon, the cords broke, and it soared aloft, quickly disappearing among the clouds.

# The Screw Propeller and Aerocurve in Theory and Practice.

## By MR. FREDERICK WALKER, C.E., of Oxford.

A GENERAL meeting of the Aeronautical Institute and Club was held on Friday, June 6th, at St. Bride's Foundation Institute, Ludgate Circus, E.C., to hear a paper from Mr. Fredk. Walker, C.E., on the above subject.

Dr. F. Alexander Barton, president of the institute, occupied the chair, and amongst those present were: Mrs. Barton, Messrs. J. F. Carter, A.I.E.E., T. W. Bennett, W. Child, A. E. Gaudron, — Pouchel, P. L. Sénécal, A. J. Melville, E. C. Dwyer, G. Nicholl, H. Coldman, W. G. Harding, C. H. M. A. Alderson, M. Felsenthal, J. Felsenthal, J. C. Blanchard, H. McNair, M. P. Dobbs, W. H. D. Maid, and O. C. Field (honorary secretary).

The President said he was sorry, and he was sure all present would be sorry, that Mr. Walker was unable to be present to read his paper in person, but Mr. Benjamin King, A.I.M.E., had undertaken to read it for him.

### THE SCREW PROPELLER AND AEROCURVE IN THEORY AND PRACTICE.

It is not in the truth a man possesses, nor that he believes he possesses, that his worth lies, but in the honest endeavour he puts forth to secure that truth; not by mere possession, but by persevering search are his faculties enlarged, and alone contribute to his ever-growing perfection.

I remember, in the early days of the screw as a marine propeller, the late Mr. Bryan Donkin, the "Father of the Institute of Mechanical Engineers," and under whom I served my apprenticeship, stating that the "paddle was better in theory than in practice, and the screw better in practice than in theory." That was in the sixties, and I thought I understood the action and construction of screws as propellers in air and water until twenty years ago, when the advent of electric launches involved me into designing propellers under new conditions—that is, high speed and short pitch. And the practical result was a revelation of facts that completely upset all known theories and preconceived formulæ. Here, then, was "negative slip" a considerable factor in propulsion, the measured dynamic value of the thrust merely nominal, and every recognised law negated. Repeated experiments resulted in success, and then I was enabled to see how to design a proper propeller for aerial navigation, and that the new theory in every way coincided with practical proof in the elastic medium afforded by the atmosphere. This, epitomised, forms the subject matter of my paper to-day.

A screw propeller of the schools of design is a section of a thread of coarse pitch, deeply cut, and forming a blade. Neglecting slip, one revolution should advance the body to which the propeller is attached a distance equal to the length of the pitch, any degree less is loss due to "positive" slip. If, on the contrary, the body advances at a greater velocity than that theoretically due to the pitch and speed, it is then "negative" slip.

As a matter of fact, the screw propeller does not "screw" its way through the air in a manner analogous to the action of a screw and nut, but the progression is due to displacement of air, the stratification of a column of displaced air in various degrees of density due to compression, and the object of designing such a propeller is to utilise the produced currents to the best advantage for propulsion and raising of the airship in the most efficient manner.

The co-ordination of the functions may be rendered as follows, in terms of time, space, and weight, the latter term being synonymous with power:

| | | |
|---|---|---|
| Time-space | Pitch<br>Velocity | Displacement and power. |
| Time-space | Circumference<br>Velocity | |
| Time-space | Pitch<br>Area | |

Now, in order to find the effective area of a three-blade propeller and also to value the centrifugal displacement, I constructed a metal face, equal to the radius, and bent over the edge so as to embrace the periphery of the blades as nearly as possible. Orifices 0.5 square-foot area, five in number, were pierced on the rectangular strip, and one on the peripheral strip, and zero anemometers were set in each, the indices of which could be read externally. This apparatus I term an "areameter." Having determined the critical velocity, starting from the tip or periphery, the readings were as follow: 0.068, 0.082, 0.079, 0.018, and 0.002, the centrifugal reading being 0.013—under the circumstances a loss. Rendering this graphically, so that the abscissæ are in terms of pressure and the ordinates equal parts of the radius, the resultant irregular curve shows the efficiency of the rotating area as a propeller. It is obvious that one-fifth is inoperative save for purposes of attachment. Therefore, in a propeller of this kind we find by experiment that we may adopt a formula—

$$A = D - \frac{D}{5}$$

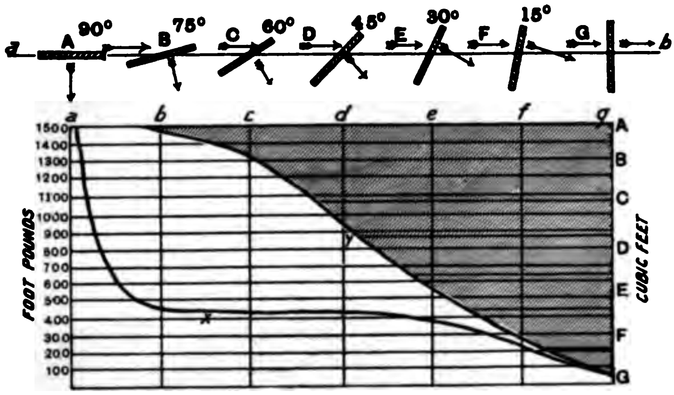
where A = effective area and D diameter. Or, in other words, let $d_1$ be the diameter of a space in the centre of the area, then $d_1 = \frac{D}{5}$. Then the total area being $D^2 \times .7854$, effective area = total area $- d_1^2 \times .7854$, and blade surface effective area × .628 a constant proved by the areameter, the surface area of each blade being $\frac{\text{blade surface}}{n}$, where $n$ is the number of blades. From the neutral (assumed) opposing air surface to the active diversion of propulsion and resultant degrees of density at the back of the propeller, the vortical condition of the disturbed molecular mass of elastic fluid must not be lost, one blade cutting it with the leading edge and forcing it backwards according to angle and velocity, and the following blade entering before the reaction allows the molecules to reassume the inertia incident to equilibrium. The negative slip cannot be attained at a low rate of speed of the propeller; the momentum is due to the velocity, hence the dynamical effect. But this relatively high rate of speed is inimicable to the use of multiple blades or cross pitches, for the reason I will endeavour to render in plain language. Although the air is an elastic medium, a given space of time is necessary after one blade has passed a certain point for the re-combination of the molecular mass, that the next blade may utilise its surface energy effectually upon a practically inert mass. If the velocity of rotation be nearly proportionate to the velocity of re-combination, the energy is expended at a loss;

and at a less velocity, with more propeller blades, the same effect takes place. As a matter of fact, I have experimented with one blade up to six, finding the best velocities to be—

| | | | | |
|---|---|---|---|---|
| 1 blade | ... 600 | revs. | per | minute. |
| 2 blades | ... 430 | „ | „ | „ |
| 3 „ | ... 220 | „ | „ | „ |
| 4 „ | ... 160 | „ | „ | „ |
| 5 „ | ... 100 | „ | „ | „ |
| 6 „ | ... 73 | „ | „ | „ |

and eventually decided that three blades at a circumferential velocity of from 3,700 feet to 5,000 feet per minute fulfilled the requirements with the maximum efficiency.

Now, before we consider the pitch as appertaining to a helix, we must study the screw blade in its angular position relatively to the plane of the axis. Here (fig. 1) upon the line *a b* are seven positions of a blade—A, B, C, D, E, F, and G—*a b* representing the axial plane. Now A and G are two neutral positions, so far as propulsion is concerned, for A being parallel to the axial plane, utilises the maximum energy in rotation by displacement without propulsion. G, in contradistinction, is also neutral by using the minimum energy without propulsion. Therefore the most effective angle is to be found between A and G, and from that can be derived the pitch. In the diagram the two curves were plotted by using six propellers of equal diameter, but varying pitch, and shrouded so that a reading of the pressure and volume of air displaced at a given velocity was measured, and the power also carefully measured, by the double test method in ordinary use when carrying out such experiments. A Salter's balance was attached to an oil bath, ball bearing thrust block, and then I found the theoretical thrust and dynamical thrust did not approximate reasonably, and that the work done in propulsion was greater than would be indicated by the thrust. In fact, the positive side of the blades acted in displacement, and the negative "cavi" result obtained upon the other side, so that to a great extent a fulcrum was obtained upon the denser stratified column of air in displacement. At a constant velocity, be it remembered, the fluid molecules successively driven aside by the blades experience the same displacements, receive the same velocities, and at different instants of motion meet the same resistance. Variable motion, accelerated, causes the fluid molecules to receive greater and greater degrees of velocity, and as they appertain to an elastic fluid, the fluid "prow" (for want of a more euphonious name) acquires a density and mass always increasing, and it follows that the mass displaced increases at the same time rate as the velocity imparted to it. Con-



* FIG. 1.

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* It will be noticed by those who read Mr. Walker's paper carefully that the diagrams used do not, as a matter of fact, fully apply. The author has promised to furnish a better set, but the exigencies of going to press did not allow of these being finished in time for the present issue. They will, however, be published in the next number of *Flying*.—ED.

ceive, then, *a priori*, the greater acceleration of motion due to longitudinal progression plus the displacement due to the propeller, as $\frac{v}{t}$ is to the resistance. Then the expression of resistance of the air must comprise, among other terms, one due to acceleration itself. This apparently false thrust impulse is rendered clear, although it is by no means an easy task to elucidate such a complex condition, which is apparently a paradox without undue prolixity.

But now referring to the diagram, the curve $a\ y$ G, the abscissæ of which are read in terms of foot-pound seconds on the unshaded side, indicates graphically the power expended in producing a result in cubic feet of displacement shown by the curve $a\ x$ G under the conditions shown by A B C D E F G. It is to be remembered that normally the negative line of force is parallel to the axial plane, and the positive always at right angles to the surface. The conditions involving an extended cavi are not introduced at this time. The maximum displacement with minimum power evidently lies between $d\ f$, and may be better localised by the intermediate angles 32° to 20°, which now define the pitch. Thus, if $\theta$ be the angle and P = pitch and D peripheral diameter,

$$\tan\theta = \frac{P}{D}$$

Therefore if two blades only are used the pitch will be D × 1.45, and with three blades D × 1.33.

In order to ascertain the manner in which with a given screw the slip varies in proportion in functions of the pitch, it may be shown as a graphic curve, the abscissæ representing the pitch and the ordinates the co-efficient of slip. Here the curve which represents the law of variation will have for asymptote the right line, of which the equation is $y = 1$ infinite pitch, advance $o$ — coefficient, that with four blades the slip increases from 0.305 for every increase of pitch from 1.935 feet to 6.381 feet, and the increase of slip is in arithmetical progression, while the pitch increases in geometrical progression, which remains constant until P = D × 4.

Then the absolute fraction or section of a true helix is altered to conform to the necessity for an increasing pitch, and also providing the cavi for the negative result, which is adverse in the ordinary adaptation of the screw propeller, but an important factor in aerial navigation, as I have endeavoured to demonstrate, and will now endeavour to show in its complete development. In constructing a screw of uniform pitch to make the increasing pitch, a guide plane is used bent to conform to the circumference of the screw, but a portion of a rising curve called a "directrix." As screws for aerial navigation are "shaped" instead of being cast, I have found in practice that it is best to commence by moulding a clay base of sufficient mass, and subsequently making a plaster cast from it, the latter if attached to two free sheet-iron collars, to allow of the working surface being placed in the right radial position for shaping the blades; the main radial arm should be made of either T or L section aluminium magnesium alloy or rolled steel, and should form the positive edge. If a textile material is used for the surface an open mesh webbing of Delta metal should be laid upon the plaster pattern, and the main radix of T or L section should be tapered towards the periphery, and bent at right angles to the width of the blade and the proper angle relatively to the axial plane deduced from the chosen pitch, which is correct at the periphery.

The negative edge is formed of a suitable stout Delta metal wire stay, with a right and left-handed screw tension coupling. When the webbing is bound and brazed the fabric is stitched into the cross members, and closed over the negative and positive radixes by double fold stitching. I prefer, however, a steel sheet surface laminated by slitting from the negative radix to about two-thirds of the entire width of the surface of the blade. The 0.75 millimetre sheet malleable steel is best, and before bending the laminæ round the negative radix I always interpose a thin layer of leather to prevent vibration, but the actual construction is capable of much modification, and therefore I need waste no time upon it; suffice it to say, that the proportions and shape, constituting the design of the propeller, are of the utmost importance, having in view the attainment of maximum efficiency with the expenditure of minimum power. Science and skill should not be spared at this point, for a loss of power is a gathering increment, but not to say conducive to absolute failure.

Presuming, therefore, that the propeller is proportioned and constructed, we have next to ascertain the best way of utilising the negative slip or cavi result. Without attempting to advocate any type of airship, I must go so far as to say that a propeller must be fixed upon each side, partly enclosed by an aeroplane system, and must be above and forward of the centre of gravity of the airship, the driving mechanism being below the aforesaid centre of gravity.

We have seen that the pressure of the displaced volume of air varies, and may be measured by the "areameter" or equivalent at different points on a radial line. When there are three blades used on the propeller the radius should be divided within the effective limits into three divisions for the purpose of properly utilising the divergent waves due to the compression of each as they follow in sequence. If such a propeller on a small scale be tested within a glass tube filled with a liquid medium in which a light pulverised matter is mixed, when the propeller is rapidly rotated the vortices in front of it (presuming this to be the direction of propulsion) assume the appearance of the threads fed into a yarn-spinning machine, and the resultant helical curves on the compression side are similar to a three-stranded yarn. The analogy is not good, but it serves the purpose of illustration. Now the centrifugal forces due to the three convolutions in sequence are in every way a lifting power if properly directed to the surfaces of aeroplanes or aerocurves, whilst the direct displacement in a horizontal or angular direction in the plane of compression, which is parallel to the axis of the propeller, is a propelling power. Having, then, ascertained the value of the compressing force at three points of the radius by the "areameter" or any equivalent means, the available lifting power in pounds per square foot may be calculated as upon the surfaces of three superimposed aeroplanes or aerocurves. Let $c\ d$ = diameter of the propeller and $a\ f$ the horizontal plane, $a\ g$ being the true axial plane, the angle $\theta$ = 10, any suitable angle between 5° and 15° being chosen according to the general conditions of construction; set off $a\ b$ = $P^2$ on the line $a\ g$, and $c\ b$ will then represent

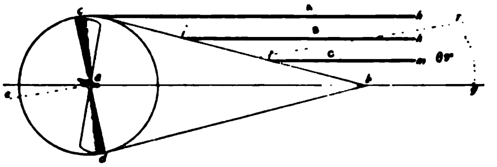


FIG. 2.

the positive edges of three aeroplanes or aerocurves A B C, the edges being at *c i l*, and the opposite edges being equal, as *h k m*. The three aeroplanes A, B, and C are placed to receive tangentially the diverging rays of force in varying pressures as previously ascertained. Now the total resistance to descent of the inert mass in a state of rest, allowing for acceleration, will be in proportion to the area *c h* of the largest upper plane A. The time does not admit of considering the details of the aerocurve action in respect of quantitative analysis.

Now when an air current exists under atmospheric conditions, or is induced by displacement, as in the case of a screw propeller, it must not be construed to represent or to exist as a force acting in a given plane without deviation. It invariably assumes a wave movement in the direction of a given plane, it is true, but with the sinuosity of a series of unbroken regular waves. Further, although broken and displaced by the action of the screw propeller, the waves are reformed in the compressed volume displaced, and, although closer together and of less magnitude, they still exert an influence upon the opposing surfaces due to their shape and velocity. The frequency and magnitude of these undulations vary according to the velocity of the current. There is no such thing as absolute quiescence in nature; a calm, windless day is apparent to ordinary sensory organisms—a beautiful fancy, but non-existent as a fact. The infinite ether comprising intersteller space is ever pulsating with this wave movement, which, however, has no potentiality as a force until reacting upon molecules, in a volume such as atmospheric air, when the wave movements are reproduced. The atmosphere varies in density considerably owing to changes of temperature within comparatively short distances, caused, let us say, by the interposition of a small cloud between the sun's rays and a particular point. This effect is transient, but since *vis inertia* is but a function of density, it follows that the waves are not regular in magnitude nor velocity. On what is apparently a perfectly calm day, when a feather dropped seems to have no deflection, the insensible wave may be recorded by a delicate anemometer, and its periodicity of recurrence noted. If a plane is moulded on the lines of the average wave curve, and presuming that the surface friction is negligible, forward motion and suspension may be effected by the expenditure of a small amount of energy. For instance, such a plane calculated to present 2.3 square feet of undulatory surface per pound weight, at an angle of 7° opposed to a wind current of 36 feet per second, if propelled at a velocity of 2.52 feet per second against the resistance is *in equilibrio*. It does not advance, nor does it fall; its position is that of a kite without the string. From this small experiment it may be seen that the power exerted in overcoming air resistance in the shape of wind pressure, and the force of gravity, is relatively small, and within certain limits an airship of large dimensions is more effective than a small one. And again, when an aerostat is used in combination with an aeroplane or aerocurve system, it should be under the following attendant conditions:

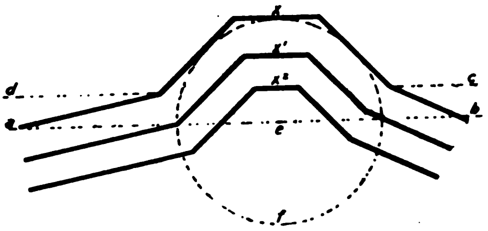


FIG. 3.

(1.) It should be an auxiliary in raising and supporting the structure, merely compensating the weight to some extent, and the whole should not be dependent upon it to such a degree as to render the failure of this part disastrous.

(2.) The outer envelope should be strong, stout, and weather-proof, and the bows shielded by sheet metal.

(3.) The gas envelopes should be numerous, and each independently connected to a pump system, so that they can separately or together be exhausted to any degree of deflation into a pressure chamber, or be inflated therefrom, in the same manner, with separate valves.

(4.) The framework should be like that of an inverted ship, with the keel uppermost, the motor and aeronaut being in the rigid structure below the centres of gravity and buoyancy, and the side twin propellers forward of and above the centre of gravity.

(5.) The aeroplane or aerocurve surfaces should be angular relatively to the axial line, and above the propellers and also the centre of gravity, and should occupy two-thirds of the length of the airship.

(6.) If the prime motor actuates a dynamo generator directly, and the current be carried to two electro motors upon each propeller-shaft, the lateral stability may be effected by a volume of mercury carrying a metal roller establishing differential contacts due to the rolling motion, and checking at the same time the velocity of one propeller, and accelerating that of the other. Longitudinal stability is effected by the movement of a large volume of mercury from the centre to either end of a long pivoted tube, which is automatically regulated instantaneously by hand or by a small motor.

I am quite aware that my colleagues may deem me guilty of dogmatism, and perhaps justly, yet my intention is merely to accentuate the importance of the aeroplane or aerocurve.

It is obvious that an aeroplane, if sufficiently elastic in its general structure, is an efficient resistance, but since we have seen that air currents in nature do not move in straight lines, but even when mechanically disturbed assume an undulatory or wave formation, it follows that the opposing surface should more or less partake of that shape also, having, however, an element of resistance to absolute freedom of movement, which has a direct action, independently of "skin" friction. This leads us to consider the proper shape of an aerocurve. The resistances are of a dual nature, as we have seen, and therefore we have to combine upon the positive surface a focus for the molecular forces due to displacement and compression where these may combine to form the "moment" of activity. A curve, of which the asymptote B C (fig. 4) is parallel to the axial plane of the screw propeller, best meets this requirement, and a cissoid presents a surface nearly approximate to a right angle tangentially to the lines of molecular force. The asymptote being set out B C parallel to the axial plane, and at distances one-third of the radius (carrying out our original assumption of a three-bladed screw), the abscissa $x = \frac{A\,B}{3}$, and the axis $a = A\ B$, and if $y$ be the ordinate, then

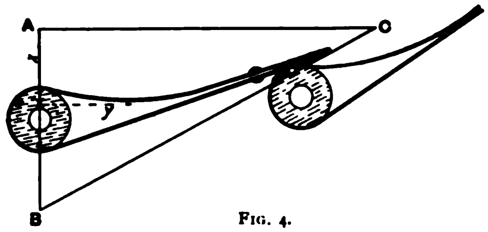


FIG. 4.

This, being taken from large diagram, is faulty in scale.

$$y = \sqrt{\frac{x^3}{a-x}}$$

Then the cissoid B C represents the positive surface with the "gathering" edge C and accumulating area up to the moment A D, and so on until the number of superimposed curves have absorbed the energy originally imparted. It will be at once apparent that to obtain the maxmum effect as a parachute the angle of the system of aerocurves must be altered to present a horizontal plane, or rather slightly in advance of it—185°, for example.

A wide range of structural difference is open to the designer, but with the fundamental principle in view he may adapt various devices to meet various conditions of application.

Referring to the depression of the positive surfaces of the aerocurves, it is a variable factor and proportionate to the difference between the weight of the airship and the area of the sustaining surface, but always within the degrees of 10 to 20 relatively to the vertical plane, as shown by the diagram of the end view.

I am prejudiced in favour of sheet metal areas, mounted upon tubular ribs, with wood or other light resilient bushes, properly stayed and supported. Fabric is not lighter in the end, when the additional supports and dressing are taken into consideration.

In conclusion, I shall feel humbly satisfied if I have in the very least part contributed my iota to the grand total of the revealed truth we are all anxious to attain. Individual effort is useful only in proportion to its place in the aggregate, and should be given without bias or prejudice, subject to correction, and without reservation to the community for the benefit of humanity. They err greatly who impute interested motives to the earnest searcher after truth in the realms of science, beyond that interest inseparable from earnest application. Speaking from experience, I do not know a bricklayer's labourer or a chimney sweep who would be satisfied with the financial position of a true scientific pioneer. This work is *con amore*, and his reward lies in the advancement of civilisation, in the vastness of which his contributed mite is lost in obscurity. Yet is he happier than many an envied plutocrat for having in a humble way assisted in the attainment of perfected truth.

### Discussion.

The President remarked that the paper had been a very interesting one, but as it was so full of mathematical formulæ, he thought it was rather difficult to grasp at the first reading, and he personally would prefer to wait till he could read it in print before venturing to discuss the various points that had been raised. The chief points were as to the pitch of the screw, the number of propellers, the rate of revolution, etc. Another very interesting part of the paper was that in which Mr. Walker gave his ideas as to what he considered to be the ideal airship. He did not know whether he understood the author aright in assuming that he thought it should be a combination of aerostat and aeroplane. He quite agreed with that view, because it was impossible in safety to experiment with aeroplanes as they were now, and with the present limited amount of knowledge on the subject.

Mr. Bennett was understood to say that he had been experimenting at the Crystal Palace with an aerocycle, but that his resources would not allow of his carrying out all that he contemplated.

The President had to recall him to the subject matter of the paper several times, and Mr. Bennett said he was merely endorsing the lecturer's views from his own experience. His own experience was that the propellers must be vertical for ascent and horizontal for progression.

Mr. Gaudron asked for further information in regard to the column of mercury, which had been referred to in the paper, and

The President said he understood it was entirely for balancing purposes.

Mr. Blanchard asked for a fuller explanation of the electrical governing apparatus referred to as having been described in the *Electrical Review*, which we quote on p. 115.

Mr. King said it operated a series of rheostats, and might be compared with the governor of a steam engine.

Mr. Blanchard, continuing, said in regard to the general question he was as alive as anyone to the necessity of studying this matter of aerocurves and aeroscrews, and he thought highly of the efforts which had been made by the pioneers of aeronautical art, such as Professor Langley, Sir Hiram Maxim, Chanute, Pilcher, and a host of others, towards solving the problems involved. Mr. Walker's contribution to the subject that evening was of no mean order, but he might perhaps be permitted to ask, with all due deference to those who had written and experimented on the subject, and with all good will and fairness towards Mr. Walker, whether all these calculations and observations were of very much value from a practical point of view. He saw before him practical aeronauts like Mr. Gaudron, and he wondered what such men would think of the value of this paper and of the practical value of the results obtained by other investigators. He was inclined to think that Mr. Gaudron, as a practical aeronaut—very likely one of the most practical aeronauts of the present day—felt rather sceptical about it. There were eminent men on the continent of Europe who had done valiant work in this direction, and had compiled columns and columns and pages upon pages of mathematical formulæ. Personally, he had had the pains and the patience to wade through a good many of those figures, and whilst he liked mathematical calculations as much as anyone, yet at the same time, looking at this matter from the point of view of a practcal aeronaut, he regarded all these investigations with disappointment and diffidence, for he could not help recognising the essential element—the fundamental factor—which so often upset and nullified all these abstruse and laborious calculations. He could not but remember the words of a celebrated practical aeronaut, who exclaimed in regard to those who made abstruse calculations, "You gentlemen, not one of you will stake his little finger on the mathematical formulæ, no matter how victorious these mathematical formulæ may be." He was quite certain they would re-echo that sentiment, as every practical aeronaut did, for there was this factor to be reckoned with, namely, the fickleness, the instability, and the unreliability of that element with which every aeronaut had to contend, namely, the air. There was nothing more uncertain, more unsafe, or less calculable than the air. When at considerable altitudes, say from one to two thousand feet, the aeronaut had not to struggle much with the fickleness of the air, but let him come down near the surface of the earth, and he must find himself at once in a very dangerous pass. He would find, if he depended on his mathematical formulæ only, that there was nothing for him but destruction, as Mr. Lilienthal and the late lamented Mr. Pilcher found out from the very same cause. What, then, had an aeroscrew or an aeroplane to do if it was to prove, he would not say victorious, but if it was to come out as acceptable to the practical aeronaut? Not only had it to be in accordance with all the scientific requirements, to conform to formulæ as to speed, pitch, and so on, but it had to resist all the sudden gusts and squalls of the air and the eddying currents, which were constantly met with near the surface of the earth. Whether it be propelled by a screw propeller, or aerocurve, or aeroplane, there must be "life" in it, it must do what the bird did, it must (so to speak) feel the air, it must feel the sudden gust and squall coming on from whatever direction and with whatever degree of intensity it might come before it was actually upon it, and it must regulate itself in accordance therewith. The aeroplane must be so constructed as by itself to present to the gust of wind its underside—its concave side—for if it were to present its convex side it would be capsized. Why did a bird manage to fly? Because it not only felt the gusts of air, but governed itself so as to meet them. It threw itself backwards, forwards, and sideways so as to meet the sudden gusts of air and take them to advantage, and save itself from destruction. Observe the bird, and they would see it constantly veering sideways, backwards, and forwards, to the right and left, so as to meet the coming gusts and squalls and the constantly eddying currents, which were always to be met with near the surface of the earth to a height of a couple of hundred feet or so. Flying machine constructors must therefore not only so design their apparatus as to make the airship of the future feel these currents of air and adapt itself to them, but the machine must do this automatically by its own spontaneous action. In short, it must be a living thing, just the same as a bird. Otherwise it would not only not come off victorious, but would share the fate of others, and the operators would be sending themselves to destruction. Whatever the aeroplane might be, whether built on the lines of Mr. Hargraves, Sir Hiram Maxim, or Mr. Pilcher, or whether it be an airship or an aeroplane—call it by whatever name they liked—it must feel the gusts and squalls of wind as they came whether in front or behind, or from right or left, and seeing and feeling them it must be able to adapt itself to their impetus. Then and then only would it carry the aeronaut to success.

Mr. Sénécal said he did not quite agree with the last speaker in saying that the paper was unpractical. He thought it led them to really practical experiments, because, after all, it was from scientists like Mr. Walker, who were specialists in their line, that practical men derived their knowledge.

The President said it was only by experiments made in the laboratory and practice tested by mathematical formulæ accurately gauged that they were able to find out what was after all most practical. In regard to such points as the shape and size of the propeller, the number of revolutions and the pitch required, calculations were necessary in order to arrive at the most efficient result for their purpose. It was only by experiments carried out by such scientific men as Mr. Walker that they were able to arrive at results which were serviceable to practical aeronauts who were not able to carry out these experiments in the air themselves. These experiments, which must of necessity be conducted in the workshop, were most valuable. What was wanted was a practical man to find out the best kind of propeller to use, and it was only by experiments such as those made by Mr. Walker that that could be done.

Mr. King pointed out, in regard to what had been said about "practical aeronauts," that these men merely went up in balloons, but to direct an aerial machine or to deal with aeroplanes and aerocurves required that a man should be an engineer. Mr. Walker was a born scientist, and he was also a practical man, who had had a good deal of engineering experience, which specially qualified him to speak on this subject. Although he might not be what was popularly called an "educated" man, he (the speaker) defied anyone to hold his own against Mr. Walker's chemical and engineering knowledge. In regard to aeroplanes and aerocurves, he was essentially a man of the future, and they could no more compare the ordinary balloons used by "practical aeronauts" with the airship which was coming than they could compare the fisherman's coracle with the Atlantic liner.

Mr. Blanchard asked to be allowed to supplement his previous remarks by saying that after having impressed upon them the necessity there was of making the aerial machine of the future a sentient, feeling, living thing, he knew he would be told that that was a very difficult problem, and that it was practically impossible. He admitted that the problem was difficult and that the task was arduous, but not altogether impossible. Their esteemed chairman, Dr. Barton, had come somewhat near to its solution. He would, however, point out with all courtesy that it appeared to him that Dr. Barton, besides providing for longitudinal equilibrium, should also provide for equilibrium in a transverse direction. The successful airship of the future must maintain its equilibrium at any time, and at a moment's notice. It must be free as a bird on the wing, it must maintain its equilibrium with lightning speed, and alter or reverse its position so as to meet the coming gusts of wind instantaneously. He maintained that it could be done by perseverance. He hoped the Barton airship solved the problem, but he was not sure, and he said this with all courtesy. He said again that a self-acting, self-adjusting equilibrium was one of the indispensable conditions for successful aerial navigation, and he felt confident that he had made a considerable step towards it.

Mr. Alderson proposed a hearty vote of thanks to the author of the paper, and to Mr. King for reading it. He endorsed Mr. Blanchard's remarks as to the necessity not only for longitudinal but for transverse stability.

Mr. Sénécal seconded the vote of thanks, which was carried with acclamation.

### PERSONAL.

Mr. Walker writes: "I regret my inability to read my paper in person, but am greatly indebted to Mr. King for his kindness, as well as the able manner in which he rendered it. I feel, however, it is due to myself to clear away a misconception as to the assumption of theory *v.* practice. I should not do justice to my late distinguished master had I not learned during thirty-seven years of active engineering work—mostly as a pioneer—to assimilate theory and practice. I may instance—not as an advertisement, but exculpatory—my service as chief engineer in Eastern liners, assistant in building the circular Russian ironclad 'Admiral Popoff,' chief constructor of the Huambo 4,000 feet altitude aerial tramway, designer and builder of the first electric locomotives in this country, and a considerable amount of heavy dynamo, motor, and accumulator construction in pioneer times. Finally, I carried out and systematised the night navigation of the Suez Canal, and plenty of other hard work where mathematical instruments and formulæ with hammer, chisel, and file have been applied with equal facility."

# Some Aeronautical Experiments.

## A Paper read by Mr. Wilbur Wright, Dayton, Ohio, before the Western Society of Engineers.

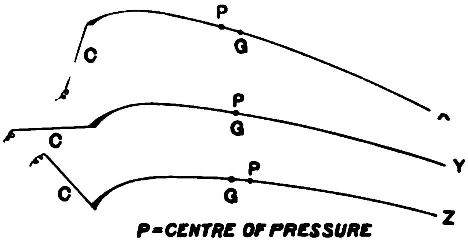
*(Continued from page 94.)*

When the time came to design our new machine for 1901, we decided to make it exactly like the previous machine in theory and method of operation. But as the former machine was not able to support the weight of the operator when flown as a kite, except in very high winds and at very large angles of incidence, we decided to increase its lifting power. Accordingly, the curvature of the surfaces was increased to one in twelve, to conform to the shape on which Lilienthal's table was based, and to be on the safe side, we decided also to increase the area of the machine from 165 square feet to 308 square feet, although so large a machine had never before been deemed controllable. The Lilienthal machine had an area of 151 square feet, that of Pilcher 165 square feet, and the Chanute double decker 134 square feet. As our system of control consisted in a manipulation of the surfaces themselves, instead of shifting the operator's body, we hoped that the new machine would be controllable, notwithstanding its great size. According to calculations, it would obtain support in a wind of seventeen miles per hour with an angle of incidence of only three degrees.

Our experience of the previous year having shown the necessity of a suitable building for housing the machine, we erected a cheap frame building 16ft. wide, 25ft. long, and 7ft. high at the eaves. As our machine was 22ft. wide, 14ft. long (including the rudder), and about 6ft. high, it was not necessary to take the machine apart in any way in order to house it. Both ends of the building, except the gable parts, were made into doors, which hinged above, so that when opened they formed an awning at each end, and left an entrance the full width of the building. We went into camp about the middle of July, and were soon joined by Mr. E. C. Huffaker, of Tennessee, an experienced aeronautical investigator in the employ of Mr. Chanute, by whom his services were kindly loaned, and by Dr. G. A. Spratt, of Pennsylvania, a young man who has made some valuable investigations of the properties of variously curved surfaces and the travel of the centre of pressure thereon. Early in August Mr. Chanute came down from Chicago to witness our experiments, and spent a week in camp with us. These gentlemen, with my brother and myself, formed our camping party, but, in addition, we had in many of our experiments the valuable assistance of Mr. W. J. Tate and Mr. Dan. Tate, of Kitty Hawk.

The machine was completed and tried for the first time on the 27th of July in a wind blowing about thirteen miles an hour. The operator having taken a position where the centre of pressure was supposed to be, an attempt at gliding was made; but the machine turned downward, and landed after going only a few yards. This indicated that the centre of gravity was too far in front of the centre of pressure. In the second attempt the operator took a position several inches further back, but the result was much the same. He kept moving further and further back with each trial, till finally he occupied a position nearly a foot back of that at which we had expected to find the centre of pressure. The machine then sailed off and made an undulating flight of a little more than 300 feet. To the onlookers this flight seemed very successful, but to the operator it was known that the full power of the rudder had been required to keep the machine from either running into the ground or rising so high as to lose all headway. In the 1900 machine one-fourth as much rudder action had been sufficient to give much better control. It was apparent that something was radically wrong, though we were for some time unable to locate the trouble. In one glide the machine rose higher and higher till it lost all headway. This was the position from which Lilienthal had always found difficulty to extricate himself, as his machine then, in spite of his greatest exertions, manifested a tendency to dive downward almost vertically and strike the ground head on with frightful velocity. In this case a warning cry from the ground caused the operator to turn the rudder to its full extent, and also to move his body slightly forward. The machine then settled slowly to the ground, maintaining its horizontal position almost perfectly, and landed without any injury at all. This was very encouraging, as it showed that one of the very greatest dangers in machines with horizontal tails had been overcome by the use of a front rudder. Several glides later the same experience was repeated with the same result. In the latter case the machine had even commenced to move backward, but was, nevertheless, brought safely to the ground in a horizontal position. On the whole, this day's experiments were encouraging, for while the action of the rudder did not seem at all like that of our 1900 machine, yet we had escaped without difficulty from positions which had proved very dangerous to preceding experimenters, and after less than one minute's actual practice had made a glide of more than 300 feet at an angle of descent of ten degrees, and with a machine nearly twice as large as had previously been considered safe. The trouble with its control, which has been mentioned, we believed could be corrected when we should have located its cause. Several possible explanations occurred to us, but we finally concluded that the trouble was due to a reversal of the direction of the travel of the centre pressure at small angles. In deeply curved surfaces the centre of pressure at ninety degrees is near the centre of the surface, but moves forward as the angle becomes less, till a certain point is reached, varying with the depth of curvature. After this point is passed, the centre of pressure, instead of continuing to move forward, with the decreasing angle, turns and moves rapidly toward the rear. The phenomena are due to the fact that at small angles the wind strikes the forward part of the surface on the *upper* side, instead of the lower, and thus this part altogether ceases to lift, instead of being the most effective part of all, as in the case of the plane. Lilienthal had called attention to the danger of using surfaces with a curvature as great as one in eight, on account of this action on the upper side; but he seems never to have investigated the curvature and angle at which the phenomena entirely cease. My brother and I had never made any original investigation of the matter, but assumed that a curvature of one in twelve would be safe, as this was the curvature on which Lilienthal based his tables. However, to be on the safe side, instead of using the arc of a circle, we had made the curve of our machine very abrupt at the front, so as to expose the least possible area to this downward pressure. While the machine was building, Messrs. Huffaker and Spratt had suggested that we would find this reversal of the centre of pressure, but we believed it sufficiently guarded against. Accordingly, we were not at first disposed to believe that this reversal actually existed in our machine, although it offered a perfect explanation of the action we had noticed in gliding. Our peculiar plan of control by forward surfaces, instead of tails, was based on the assumption that the centre of pressure would continue to move farther and farther forward, as the angle of incidence became less, and it will be readily perceived that it would make quite a difference if the front surface, instead of counteracting this assumed forward travel, should in reality be expediting an actual backward movement. For several days we were in a state of indecision, but were finally convinced by observing the following phenomena (fig. 1): We had removed the upper surface from the machine, and were flying it in a wind to see at what angles it would be supported in winds of different strengths. We noticed that in light winds it flew in the upper position shown in the figure, with a strong upward pull on the cord *c*. As the wind became stronger, the angle of incidence became less, and the surface flew in the position shown in the middle of the figure, with a slight horizontal pull. But when the wind became still stronger, it took the lower position shown in the figure, with a strong downward pull. It at once occurred to me that here was the answer to our problem, for it is evident that in the first case the centre of pressure was in front of the centre of gravity, and thus pushed up the front edge; in the second case, they were in coincidence, and the surface in equilibrium; while in the third case the centre of pressure had reached a point even behind the centre of gravity, and there was therefore a downward pull on the cord. This point having been definitely settled, we proceeded to truss down the ribs of the whole machine, so as to reduce the depth of curvature. Fig. 2, line 1, shows the original curvature; line 2, the curvature when supporting the operator's weight; and line 3 the curvature after trussing.

Fig. 1



P=CENTRE OF PRESSURE
G=CENTRE OF GRAVITY

Fig. 2

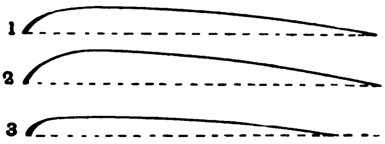


**Diagram of Pressures and Curves.**

*(To be continued.)*

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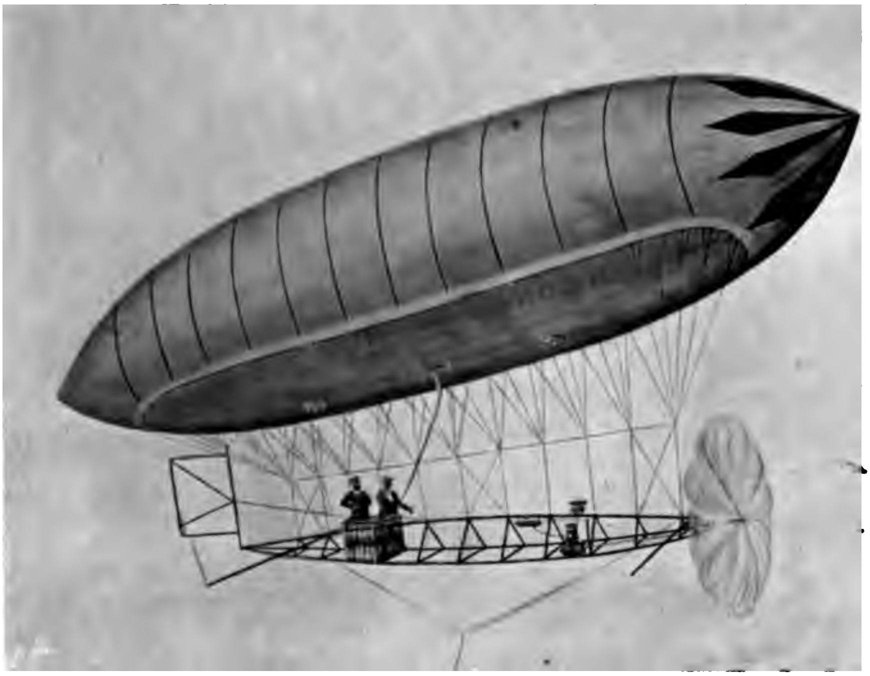
The Rev. B. Cannon, of Pittsburg, Texas, has constructed an airship said to be based on Ezekiel's specifications. Mr. Cannon is of the opinion that the Almighty was graciously pleased to show many novelties to Ezekiel, and in support of his contention he cites various passages of Scripture from the "Book of Ezekiel." The inventor states that the full-size machine is supposed to be driven by a four cylinder gas engine. The gas or compressed air is stored in the frames of the airship. This motor is connected with the ends of the mainshafts direct, and the speed is 400 to 1,200 revolutions per minute. A number of the wheels are built according to Ezekiel's designs.

# The Spencer-Mellin Airship.

M. SANTOS-DUMONT'S airship slip, or the huge shed which was built in the Crystal Palace grounds for the accommodation of his aerial vessel which was found too perished to soar after inflation with common air and exhibition in the Concert Room, has now another tenant. This is an aerial craft entirely of British manufacture, having been constructed by the well-known firm of aeronauts, Messrs. C. G. Spencer and Sons, of 56a, Highbury Grove, N., for the proprietors of Mellin's Food. The balloon or gas bag, as can be perceived from the illustration given herewith, is in shape on the lines of a solid of least resistance, and is made of varnished silken fabric similar to that used by Messrs. Spencer and Sons in the construction of their ordinary balloons. Its capacity is about 20,000 cubic feet, its length 75ft. and maximum diameter 20ft. Its weight, with netting and gear for supporting the keel or *nacelle*, is 290 lbs. The keel or *nacelle*, which in outline approaches that of a well-formed tip-cat, is made entirely in skeleton of bamboo, trussed triangularly and rigidly stayed throughout with steel wire stays. When depending by the suspension cords from the inflated gas bag it is carried 10ft. below the same, the motor, which is carried on the forward half of the keel, being placed 20ft. from the escape valve.



The engine—a 6-8 h.p. Simms petrol motor, with Simms-Bosch ignition—serves to drive a propeller made of light pine, and of shape and pitch as approved by Sir Hiram Maxim. The propeller is 28 lbs.

in weight, and revolves in a circle 8ft. in diameter. The blades are 4ft. in width at their widest part. The drive is communicated to the screw from the engineshaft by means of doubly universally-jointed propeller-shaft, steadied in its centre by an adjustable ball bearing slung by four wires from the angles of the keel frame. The engineshaft carries a steel pinion, which meshes with a gun-metal spur wheel ten times the diameter of the pinion, this spur wheel being carried on a shaft attached to the rearward universal joint of the propeller-shaft. Thus the propeller revolves at one-tenth the speed of the engineshaft, the normal rate of which is 1,500 revolutions per minute. The usual coned friction clutch forms part of the engine fly wheel, and a free-wheel clutch with starting band is also fitted to the engineshaft.

Cords from the clutch and starting clutch mechanism are led back to the aeronaut's car, which consists of a platform on bamboo supports situated in the centre of the rear half of the keel. The engine can therefore be started and disconnected from the propeller-shaft, and by similar means the sparking is advanced or retarded by the aeronaut at will. At the stern of the keel is placed the rudder, with lines to the car, from which also depends the balancing trail rope. Just forward of the car on the top of the keel frame is placed a blower, connected by silken pipe with the interior of the gas bag, and which can be operated by the aeronaut when it is necessary to control the distension and equilibrium of the balloon. The ballast control lines are also led to the car. The gas bag is filled with hydrogen gas, made at the rear of the airship shed by a gas-generating plant. The airship made its first trip on the evening of June 23rd, and successfully demonstrated its steering abilities.

## A British-built Airship.

M. PANUZZI has instructed Mr. Fredk Walker, of Oxford, to design his air yacht "Spezia." It is 230 feet in length, and the frame, of rolled aluminium bronze, is analogous to that of an inverted ship, the car being part of the rigid structure. The aerostat consists of thirty-two gasbags, within a double waterproof stout envelope. Each bag is separately connected to an electric pump, exhausting the gas into a hydrogen reservoir under pressure. Inflation and deflation may be accomplished without loss. The bows are protected by a metal shield. The aerostat is merely an auxiliary lifting power. The two propellers, eleven feet in diameter, placed angularly forward and above the centre of gravity, rotate under a triple aerocurve surface extending 110 feet from the hull on an adjustable frame. The motor is a petrol turbine, compressed air being used to form the mixture, and by its expansion through the jackets, keeping the temperature low. This type is specially designed for the "Spezia." A dynamo is driven directly from the motor, which is of 55 h.p., and operates two motors on the twin propeller-shafts. The lateral equilibrium is maintained by a gravity balance controlling rheostats on the motor circuits, and longitudinally by a long pivoted tube containing 56 lbs. of mercury, tilted by a worm sector driven by a small motor controlled by a gravity balance. Both actions are automatic and anticipatory. The total load is 6,000 lbs., and the lifting power of the aerostat is 4,200 lbs. The airship is expected to be ready for a trial trip early in August.

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Mr. James F. Carter, of Bath, represented the Aeronautical Institute and Club at the International Commission on Aeronautics held at Berlin from May 19th to 25th.

# Motor Balloons and the Pole.

### By JOHN MUNRO.

ANDREE tried to reach the pole in an ordinary balloon, unsteerable, or driven by the wind, and he was unable to land on the ice for fear of not rising again. He was, in short, at the mercy of the weather, and trusted in luck for a poleward wind of sufficient speed and duration to waft him over the Polar Sea. With a "steerable" or, as I prefer to call it, a "motor balloon," the case is different, and I propose to show how the pole might be reached by it.

A navigable balloon is automobile or self-propelled, and can travel in a calm or even against a light wind, when an ordinary balloon is useless, and it has only to fear strong contrary winds. It therefore admits of a larger variety of weather than an ordinary balloon, and in summer quiet weather is not unusual in the Arctic regions. Another advantage is that a motor balloon travelling not far above the ice can be landed on it for shelter in unfavourable weather, and, rising again by its aerial screws, continue the voyage after the storm is past.

Moreover, hydrogen, to compensate for gas lost by leakage through the silk, could be generated from the ice, snow, or sea water by decomposing it with an electric current from an accumulator or dynamo driven by the motor of the balloon. The period of the journey might in this way be prolonged if necessary.

I therefore briefly suggest the following plan to reach the pole or other inaccessible points:

(1.) Go by ship in summer as near the pole as possible—say to the north of Spitzbergen or Franz Josef Land.

(2.) Finish the voyage over the polar ice in a motor balloon, taking care to shelter on the ice if spells of bad weather occur.

(3.) Keep up communication between the balloon and the ship or headquarters, so that the position, progress, and welfare of the balloon are always known to the ship. In the event of a breakdown requiring help from the vessel, she could be provided with at least one spare motor balloon, and through knowing the position of the disabled balloon, would come to her assistance. In the last resort the aeronauts could, of course, travel over the ice like Dr. Nansen, and for this might be provided with light collapsible boats.

Motor balloons are now made to travel ten miles an hour and upwards. Dr. Barton's, made for the War Office, is a combined motor balloon and aeroplane, and is reported to make about twenty miles an hour, and keep aloft for forty-eight or fifty hours. Renard and Krebs, the French military balloonists, are producing a large motor balloon, which is to do about as much, and many other inventors are engaged on balloons of the kind.

It will not be difficult for a ship under ordinary conditions to get within 500 miles of the pole, and if they are favourable it will be possible, as in the case of the Duc D'Abruzzi, to get much nearer. At a speed of ten miles an hour the balloon would reach the pole in fifty hours, and at double the speed in twenty-five hours, or fifty hours there and back. Dr. Barton's apparatus might therefore be sufficient if adapted for the purpose. It shows, at all events, that we are now in a position to construct a balloon capable of accomplishing the feat, especially if a device for producing hydrogen is adopted at need. The performances of motor cars appear to show that there would be no difficulty in carrying petrol or other fuel enough for the voyage, which need only be a dash. As it seems but a question of design and detail, it is perhaps worth while for Arctic explorers to give the motor balloon a trial. At present much money is being spent, and many hardships endured, in adhering to the old plan of travelling over the ice—a plan which has thus far been attended with failure, and promises no better success in the future.

# Short Flights.

The committee of aerostatic experts have decided upon a figure 8 course as the aerial speedway for all flights in connection with the World's Fair prize of £25,000. Prior to the race the competing airships will have to fly a series of trials over a ten miles course, the measurement of which will be indicated by captive balloons.

* * *

Dr. Barton, the inventor of an airship to which we have already referred, and which is being experimented with by the English War Office, has been elected president of the Aeronautical Institute and Club, which holds its meetings at the St. Bride's Foundation Institute, Ludgate Circus; and he acted in that capacity for the first time at the meeting of the Aeronautical Institute on Friday, June 6th.

* * *

On June 21st the Aero Club sent up three balloons at Ranelagh Club, Barnes. The balloons were: "The City of York," belonging to Messrs. Spencer Bros.; "The Graphic," belonging to the proprietors of the *Graphic;* and "The Vivienne," belonging to Mr. A. C. Leslie Bucknall. Among the passengers were the Hon. C. S. Rolls, Mr. James Butler (president of the Aero Club), Miss Butler, and Mr. Kenneth Barrington. Mr. Leslie Bucknall descended at Rainham, narrowly escaping a large lake. The "Graphic" came to earth near by.

At Toulon, France, on June 9th, Lieut. Baudic ascended in a balloon belonging to the naval aerostatic park. The balloon went to the eastward to sea, and was followed by two torpedo boats, but fell into the water and disappeared.

* * *

The Archduke Leopold Salvator made an ascent a few weeks ago in his balloon "Meteor." Starting from Salzburg, he crossed the snow-clad Austrian Alps at an altitude of 10,000 feet. The Archduke landed safely at Judenberg, in the Styrian Alps, after a voyage of four hours.

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# Flying.

## The Record of Aerial Navigation.

WITH WHICH ARE INCORPORATED

**The Flyer, The Flying Machine, The Aerostat, The Aeronaut.**

No. 4. QUARTERLY. SEPTEMBER, 1902.

# The Bath Balloon Centenary.

BY THE HON. CHAS. S. ROLLS.

A GATHERING of scientists interested in aerial navigation took place under the auspices of Mr. Patrick Alexander at Sydney Gardens, Bath, to celebrate the centenary of the first balloon ascent made at Bath in 1802 by Garnerin, a pioneer of ballooning. At 4.20 a small sounding balloon was despatched, equipped with self-acting instruments for recording pressure, humidity, and temperature, and a pilot balloon was despatched at five o'clock to determine the velocity and direction of the wind.

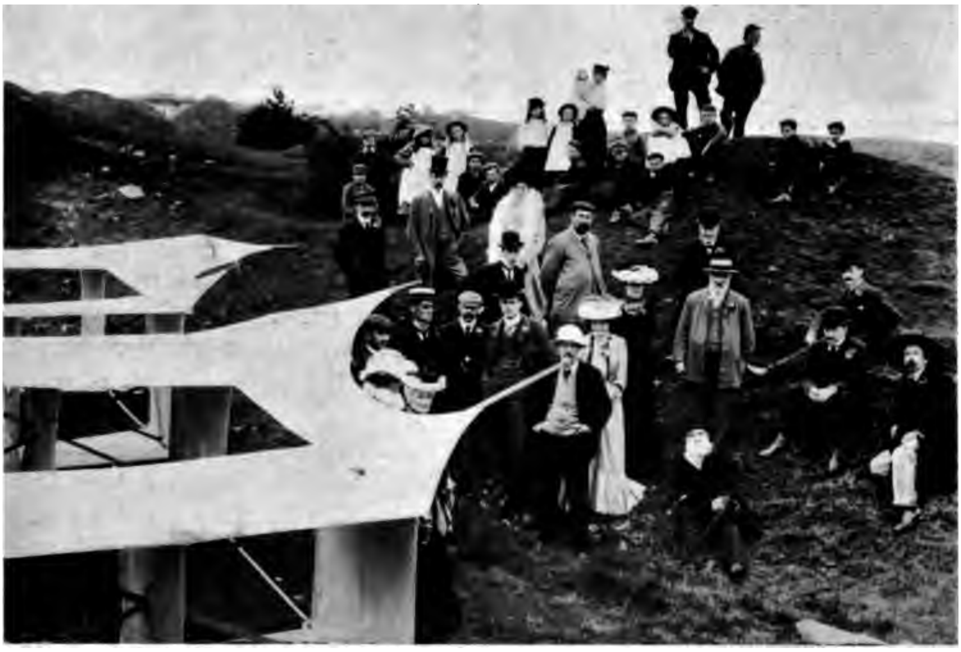
At 6.10 the "Alexander" balloon, containing 35,000 cubic feet of gas, and bearing Messrs. Gaudron and Poole, rose majestically amid loud cheers and waving of hats, it being the precise moment at which Garnerin left the same spot one hundred years ago.

A dinner was held in the evening, those present including Major Baden-Powell, Dr. Barton, Messrs. Young, Groombridge, and Cody, of kite fame; Mr. Eric Bruce, representing the Aeronautical Society; the Hon. C. S. Rolls, of the Aero Club; and Major Trollope, from His Majesty's balloon factory, Aldershot.

During dinner news was received of the descent of the "Alexander" balloon, with its occupants, near Bristol; and also a telegram with information of the finding of the sounding balloon, with its instruments intact, in the same district, the self-ripping arrangement having been adjusted so as to bring the balloon down before it had reached the coast.

On the second day the party drove out to Mr. Alexander's experimental works at Batheaston, where an elaborate programme had been prepared. Novel experiments were shown in the laboratory, where Mr. Alexander has devoted a score of years to the systematic study of the flight problem and other research work. Countless forms of wings and propellers were shown in motion, and then from the top of a high hill commenced a demonstration of Cody's aeroplanes. A fresh easterly wind was blowing, and the first machine—resembling a huge bird, some 20ft. in length, with several rows of wings—ascended into the air after the principle of a kite, but with almost sufficient lifting power to raise a man. The machine was let out on a mile of wire, and there remained perfectly steady for several hours. It seemed evident, indeed, to those present that it only required a small propelling motor to replace the pull of the wire, and the great problem would be solved. Several small kites were sent up the wire to the big machine, one of these "messengers" carrying a charge of gun cotton, which exploded downwards on reaching the top. The novel sight of these machines, and especially the report of the explosion, caused much wonderment in the district.

Considerable disappointment was felt that Mr. Cody had not brought his largest machine, but the difficulties of carriage had rendered it impossible. With this machine

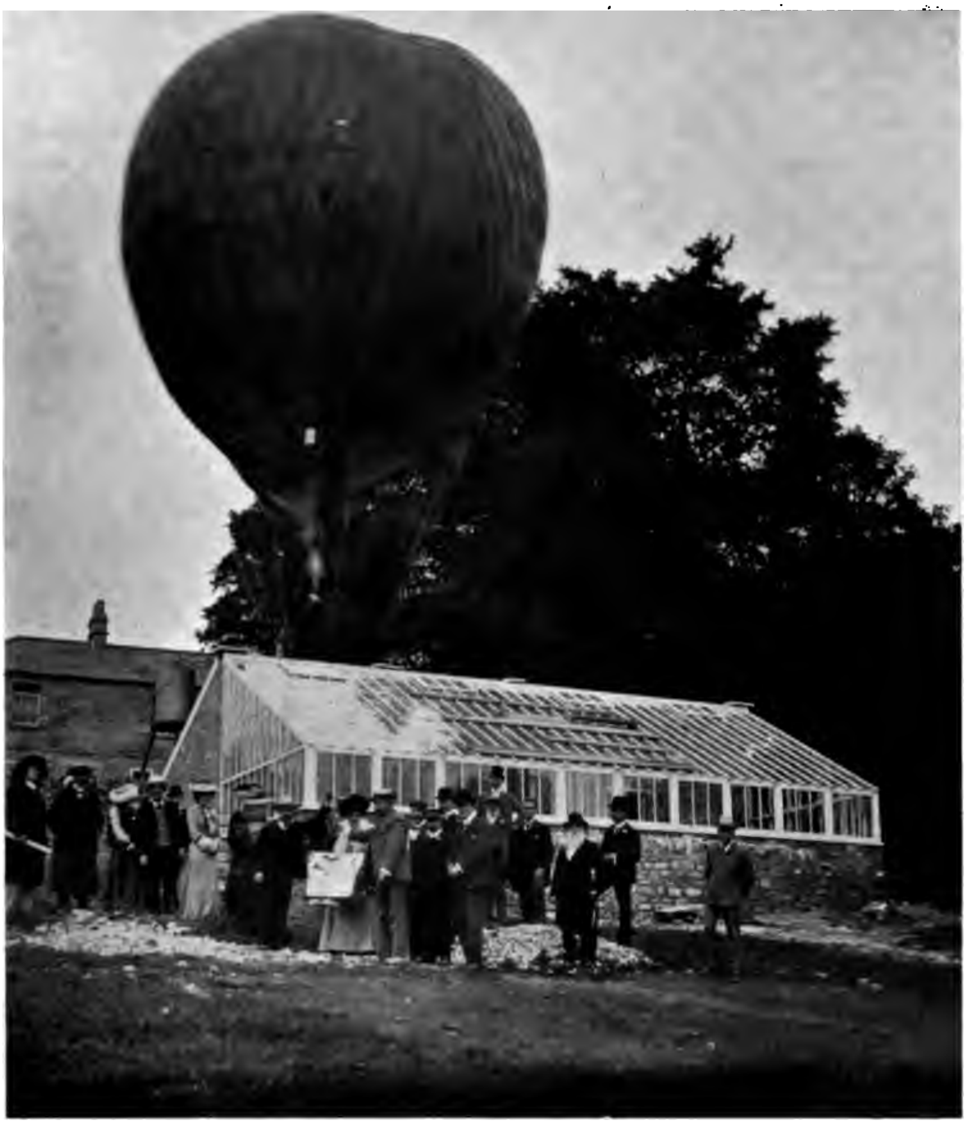


THE CODY AEROPLANE.

Mr. Cody has often been carried up the wire of the other kite sitting in a small basket, and by adjusting his angle he can "fly" up or down at any speed he pleases.

The party was entertained to luncheon by Mr. Alexander, and afterwards a "ballon sonde" was sent off carrying the usual automatic recording instruments. Some interesting results obtained by these sounding balloons in different parts of the world were then shown. Some of them were provided with automatic cameras for taking photographs of the country from various altitudes; one had attained a height of nine miles, while another had travelled from Bath to Fecamp, in France, at the rate of 120 miles an hour, having been picked up exactly one hour after its despatch.

Some further experiments were shown in the laboratory on Herzian waves, and some stray "wireless" currents were picked up on a Marconigraph, and then followed the concluding experiment, which consisted of purposely cutting the cord of the kite machine, which was then seen to descend gently to the ground without losing its balance, the object being to demonstrate



DISPATCHING A SOUNDING BALLOON FROM BATHEASTON.

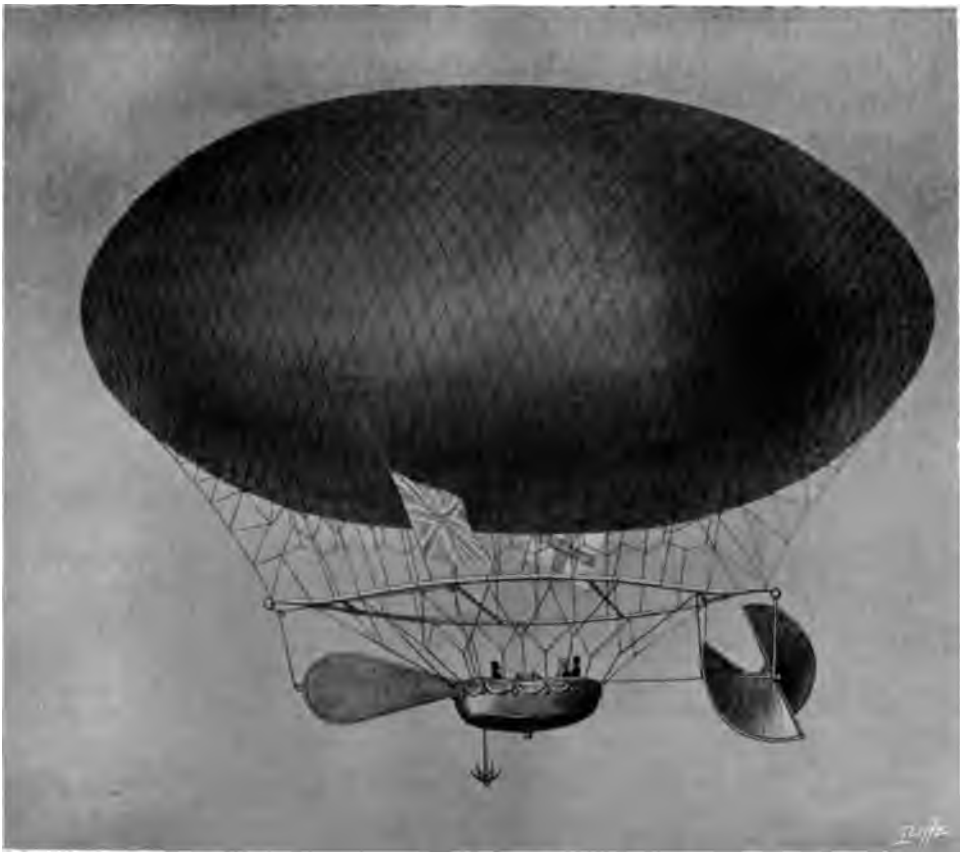
that if a flying machine built on the aeroplane principle were to have a breakdown in its propelling power the machine, if properly constructed, would not fall with a rapidity that would endanger the life of the aeronaut.

These experiments were arranged by Mr. Alexander in association with the Aeronautical Society and the Aero Club of Great Britain, and were witnessed by Major Baden-Powell, Major Trollope, Mr. Eric Bruce, the Hon. C. S. Rolls, Dr. Barton, Messrs. Field, Young, Groombridge, and other gentlemen who had come from various parts of the country, Sir Hiram Maxim being unavoidably prevented from attending.

### THE 1802 ASCENT.

We cull the following from the *Bath Chronicle* of September 9th for the year 1802:

The curiosity which had been excited in this city and throughout the country around it, in consequence of the spirited

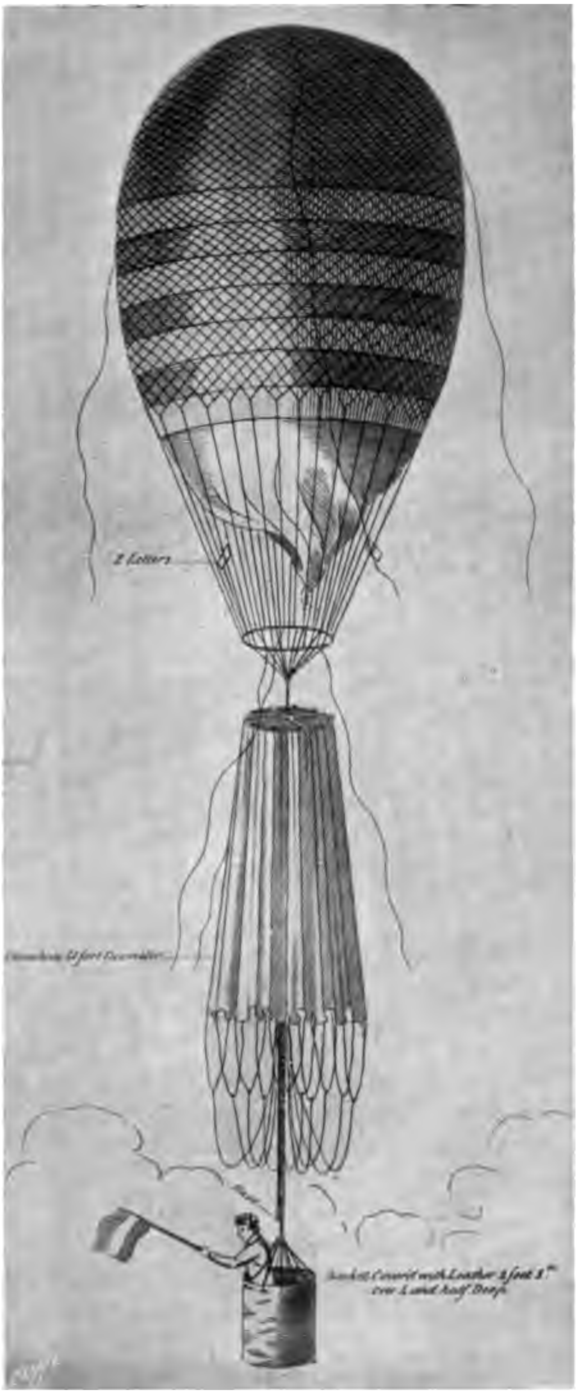


**MODEL OF MR. MONCK MASON'S AERIAL MACHINE, 1843.**

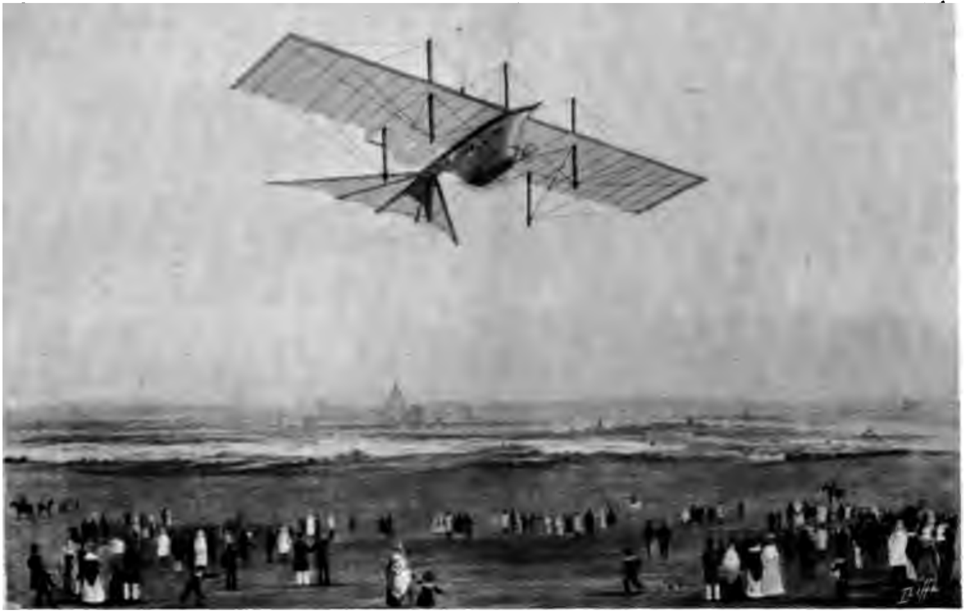
**The suspending portion of the machine was 44ft. long by 6ft. 6in. (*sic*) in height, and contained 320 cubic feet of hydrogen gas, and the whole weight of the machine and its appendages when filled was 20 lbs. It was worked by a section of an Archimedean screw at an angle of 68 degrees, and travelled at the rate of five miles per hour along the Royal Adelaide Gallery, Strand, where it was exhibited.**

step taken by Mr. Gale, for the gratification of the public, the engagement of M. Garnerin to ascend from Sydney Gardens in his balloon yesterday afternoon, was gratified to its amplest extent by the most sublime spectacle ever exhibited here. The beauty of the afternoon, the clearness and stillness of the atmosphere, added infinitely to the interest of the sight, not only on account of the steady and prolonged view which it allowed us of the gallant aeronauts and their stupendous machine, but also because it precluded that alarm which would have been naturally entertained for the fate of the aerial voyagers had the circumstances of the weather been less favourable to the expedition.

The process of filling commenced early in the afternoon; it is exceedingly simple, and was conducted in the following manner: About thirty hogsheads, containing the iron and vitriolic acid, largely diluted, were disposed in circles; a tube affixed to the head of each vessel conducted the gas produced into another vessel inverted in water, whence the whole accumulated air was conveyed through an oil-skin tube to the bottom of the balloon, which was situated in a railed area in the middle of the grand walk. Immediately before his ascent, in order to give a more complete view of the balloon, M. Garnerin, with his companion, Mr. Glasford, was towed, at a slight elevation, to the summit of the walk, and back to the enclosed space. After they had saluted the company, about half-past five the machine gradually

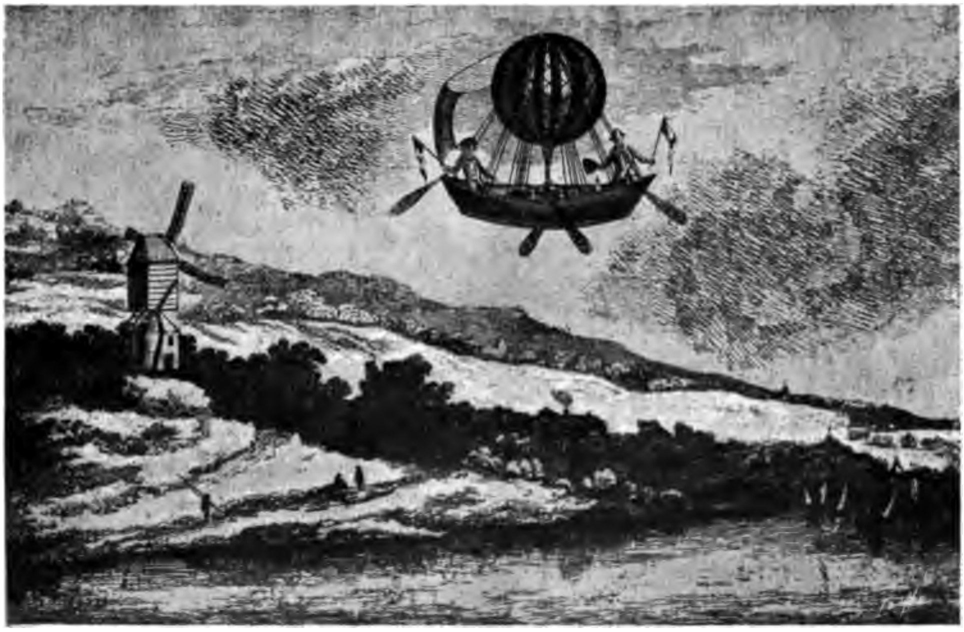

2 Letters
Basket Covered with Leather 4 feet 3 in
over 2 and half Deep

**Balloon, with parachute, which ascended from St. George's Parade, North Audley Street, Oxford Street, Sept. 21st, 1802.**



**AERIAL STEAM CARRIAGE**—the first carriage of the Aerial Transit Co., 1843.

The year 1843 is noted for the greatest attempts which had hitherto been made to construct an aerial ship of which Mr. Henson, C.E., was the designer. It became so popular that on the motion of Mr. Roebuck the Aerial Transit Bill was read a first time in Parliament. A trial of the air-ship soon proved its defects. The invention, however, attracted the attention of the scientific world both in Europe and America.



A REPRESENTATION OF MR. BLANCHARD AND DR. JEFFRIES'S BALLOON

Descending near Dartford, Kent, 30th November, 1784 ascended, sailing slowly and majestically, in the direction of the wind, above the valley, till it was lost behind the hills to the right of Prior Park.• The neighbouring eminences crowded with gazing multitudes and richly illumined by the declining sun, the gardens filled with elegance and fashion, the streets and roofs of the houses covered with spectators, and the balloon grandly sailing through the blue expanse, presented a picture which can only be conceived by those who were, like ourselves, spectators of the same. About a quarter past seven M. Garnerin and his companion descended in perfect safety in a field near Mells—a distance of sixteen miles.

—

# Chasing a War Balloon.

AN exciting chase after a war balloon was started from Stamford Bridge on August 30th. The Rev. J. M. Bacon was the originator and promoter, and the idea of it was that, in order to capture the balloonist when he descended and to seize his despatches, cyclists should pursue the fugitive balloon through the country. The balloon started on a south-westerly course, and for a time drew slowly away from a party of nearly eighty cyclists. After a time, however, the pace of the balloon became hopelessly slow, and the cyclists finally ran their quarry to earth in a cornfield near Leatherhead, when "Commander" Bacon surrendered and delivered up his despatches. Unfortunately, one of the spectators lost his life through clinging to a rope attached to the balloon. He was carried to a height of about sixty yards before he let go the rope and fell heavily to earth.

THE REV. J M. BACON ABOUT TO START FROM STAMFORD BRIDGE GROUNDS.

# Motor Aviation of To-day and of Recent Years.

## By SIDNEY H. HOLLANDS.

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(Continued from page 119.)

### AERIAL STABILITY.

Mr. Hargrave, when experimenting with his numerous and varied rubber-band driven models, was bothered by the centre of gravity shifting along the machine, as the rubber bands shortened by contraction, so that he had to design these models with the right percentage of the sustaining surface or "body plane" longitudinally ahead of the mean position of centre of gravity. Mr. Hargrave says in one of his papers read before the Royal Society of N.S.W.: "A number of experiments regarding the positions of the centres of gravity and of effort were made, so that the risk of damage to a valuable machine might be minimised. A cross-bow was made for discharging various forms of stick and paper models with adjustable weights. It is found that if more than twenty-five per cent. of the area is in advance of the centre of gravity the models turn up, and wreck ensues as a matter of course."

As an instance of the resourcefulness brought to bear by Mr. Hargrave in the development of these admirable models, the following further extract may be quoted from the same paper: "At first I stretched the indiarubber from aft forward, but in most of these models it is stretched from forward aft. The reason for the alteration is that as the indiarubber contracts the centre of gravity of the machine is shifted towards the fixed end of the indiarubber, and if there is power sufficient to propel the machine upwards at starting we want the centre of gravity moved forward to decrease the angle of elevation as the power of the elastic decreases."

For transverse stability Mr. Hargrave made the lateral halves of the main sustaining or "body plane" at the "diedral" angle, which has already been described and illustrated (see also description of Prof. Langley's "Aerodrome"). This arrangement of sustaining surface may now be regarded as the standard provision for transverse stability. Nothing meeting the case better has yet been devised.

The maintenance of equilibrium and consequent stability must be automatically effected (this condition has been urged already herein, but it cannot be too strongly insisted upon) in order to meet all possible emergencies, and if practicable there must be even greater stability than birds are endowed with, as man and his aerial structures are at a distinct disadvantage when compared with these, which are, as Mr. Chanute happily described them, "instinctive acrobats," and ever alert at all points. It is even said that the albatross occasionally sleeps on the wing.

The automatism of man's aerial machine would supply the place of the bird's marvellous instinct, its constant vigilance, and agility.

Mr. Le Bris in 1867-8 in France, Herr Lilienthal in 1894-7 in Germany, Messrs. Chanute and Herring in 1896-8 in America, and Mr. Percy T. Pilcher in 1896-9 in England have all achieved extraordinary feats in the way of preserving the equilibrium of their respective aerial sailing or gliding machines. This was done sometimes even in high winds, and then, in particular, they must have been wonderfully on the alert and prompt in manœuvring. Longitudinal instability has been the great trouble with these machines, and this has had to be incessantly battled with by the judicious and active exercise of the "air gymnastics" that Dr. Lilienthal told us he had to resort to.

It is a significant fact that Lilienthal's and Pilcher's machines, both of which ultimately caused the death of their operators, were not provided with automatic longitudinal stability, and in both cases the fatal plunge was preceded by an involuntary somersault of the entire machine—in one case forward and in the other backward. This further emphasises the necessity for automatic stability.

Now this vigilant gymnastic performance would not be practicable at all in anything larger than a one-man machine, hence the imperative need for the only safe provision in all large aerial machines.

It says much for the extraordinary skill and resource displayed by those unhappily deceased gentlemen that they prosecuted their perilous aerial exploits for between two and three years before meeting with a serious accident. Though lementably sacrificed to the cause, aviationists acknowledge with gratitude that they materially helped it forward by adding largely to our limited store of recorded practical experience.

Le Bris created a "record" for altitude in sailing flight which has not yet been broken, having once soared to a height of 200ft., sailing a distance of 600ft., and survived it.

Mr. Chanute made a happy suggestion in his book "Progress in Flying Machines," which has also occurred to the present writer, relative to air-sailing experiments, viz., that they might be advantageously and more safely practised from a ship or a boat out on the water. This could be done still more conveniently from an elevated flush platform or staging erected on a raft or pontoon, similarly to the method since successfully adopted by Prof. Langley on the wide but secluded reaches of the Potomac river. This course was apparently suggested to Mr. Chanute by the chronicling of Le Bris's exploits, due to the fact of the latter experimenter being a master mariner and an excellent swimmer—moreover, by reason of his soaring vehicle being adapted for floating on water, having a canoe-like body or car (13ft. 6in. long).

The association, however, apparently never occurred to Le Bris, for he proceeded on somewhat similar lines to Lilienthal, and although he did not meet with a fatal accident, he did on one occasion fracture a leg in landing.

Two apposite remarks of Lord Rayleigh, expressed in a paper entitled "The Soaring of Birds," written by his lordship in 1883, may be fitly quoted here. He says: "However the feat may be accomplished, if it be true that large birds can maintain and improve their levels without doing work, the prospect for human flight becomes less discouraging." Then again he points out that "when a man can launch himself from an elevation and glide long distances before reaching the ground an important step will have been gained, and until this can be done it is very improbable that any attempt to maintain the level by expenditure of work can be successful."

Lord Rayleigh expressed this latter opinion in the year 1883—just ten years, it will be noted, before Lilienthal embarked on his instructive course of gliding-flight experiments.

While just completing this article the writer received a very interesting communication from the States recounting the latest series of sailing or gliding-flight experiments by two gentlemen hitherto unknown out of America, viz., the brothers Wilbur and Orville Wright, of Dayton, O., who have made some daring but successful departures from the Lilienthal practice both in methods of flight and design and structure of apparatus. The writer purposes devoting a separate subsequent paper to their experiments at length, but will quote, in conclusion of this chapter, an apt remark of theirs, provoked by their experience: "The balancing of a flying machine is very simple in theory. It merely consists in causing the centre of pressure to coincide with the centre of gravity. But in actual practice there seems to be an almost boundless incompatibility of temper which prevents their remaining peaceably together for a single instant, so that the operator, who in this case acts as peacemaker, often suffers injury to himself while attempting to bring them together. . . The bird has learned this art of equilibrium, and learned it so thoroughly that its skill is not apparent to our sight. We only learn to appreciate it when we try to imitate it. Now there are two ways of learning how to ride a fractious horse—one is to get on him and learn by actual practice how each motion and trick may be best met; the other is to sit on a fence and watch the beast awhile, and then retire to the house and at leisure figure out the best way of overcoming his jumps and kicks. The latter system is the safest, but the former on the whole turns out the larger proportion of good riders. It is very much the same thing in learning to ride a flying machine. If you are looking for perfect safety you will do well to sit on a fence and watch the birds, but if you really wish to learn you must mount a machine and become acquainted with its tricks by actual trial."

The writer heartily endorses Messrs. W. and O. Wright's advocacy of the latter and practical course.

The alternative sedentary method described above reminds him of the case of a youth he once knew, who was fired with ambition to become a crack swimmer, but whose careful maternal parent severely bade him never on any account to enter the water until he could swim, but prescribed the safe alternative course of daily practice on the hearth rug.

### FALLACIES IN FLIGHT.

"How not to do it" is a branch of education not to be despised, and perhaps more particularly is that the case in the subject of this series. It is by rigorously weeding out the fallacies that the student of aviation is provided with a clear, unencumbered field, and is thereby enabled to "take up the running" where his less persevering predecessors have left off—where the demise of the latter has not terminated their laudable efforts.

Having already dealt finally with ballooning schemes in a previous chapter, I need say no more on that point, particularly as it does not come within the realms of true flight.

First and foremost, then, let the intending student and experimenter in flight beware of each and every scheme which purports, or appears to him, to *create* power, to produce it from *nothing*—the old, old "perpetual motion" delusion, that dies so hard, and is the wildest of all physical fallacies, as all such schemes contravene the stern and all-pervading physical law of the "conservation of energy."

I hope that now I need address this particular warning only to the tyro, or to the untechnical student of maturer years; and it is a noticeable fact that the subject of artificial flight (I do not say the study of it) has often a powerful fascination for even the lay mind.

Now, to turn from the general to the particular, the next fallacy I will allude to is that of the supposed "valvular action" of the natural wing, and the application of such a principle to aerial machines (fig. 1).

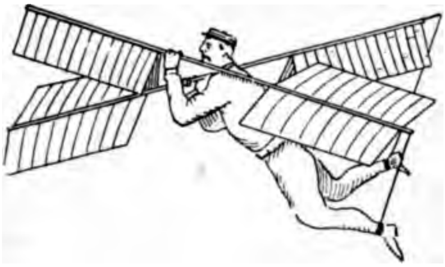


**Fig. 1. M. Besnier, 1678. The first authentic attempt at flight by "valvular" wings (alternate action).**

As I have remarked in a previous allusion to this now exploded hypothesis, it was believed that the function of the wing-feathers was to act as valves, opening on the up-stroke to reduce resistance, and closing on the down-stroke impermeably to give (as it was thought) the maximum lifting effect. We now know, without doubt, that this is a fallacy, and that the natural wing was so sub-divided for other reasons, which have been dealt with in previous chapters.

Let me confess that in my younger days I, like perhaps the majority of fledglings in aviation, did not escape being bitten by this specious fallacy, and went the length of constructing a steam model to work on this principle—which, of course, it flatly refused to do—that is, to lift itself in the air, although the little direct-acting steam motor went all right. There were two horizontal hexagonal frames having six triangular spaces nearly filled with a number of ribbon-like valves opening downward only, and slightly overlapping each other. One of these valvular frames was a fixture to the motor, and the other was fastened direct to the head of the long-stroke piston rod, centrally, and moved up and down vertically with it (fig. 2). My notion was that these slat-frames would act *alternately* as non-return abutments, exactly in the manner of the suction and delivery valves of a pump. However, as I have said, it was a delusion.

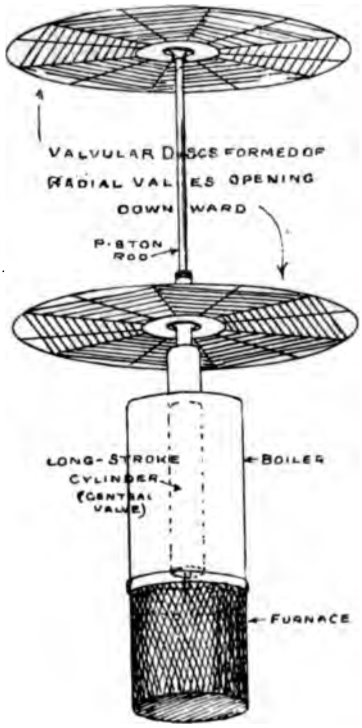

VALVULAR DISCS FORMED OF RADIAL VALVES OPENING DOWNWARD
PISTON ROD
LONG-STROKE CYLINDER (CENTRAL VALVE)
BOILER
FURNACE

**Fig. 2. Model "valvular" flying machine (original but fallacious).**

The next proposed system of aerial sustentation I purpose dealing with is one that has been "re-invented" perhaps twenty times as an absolutely new thing, so popular has been the "system" (with the uninitiated), viz., that of vertically-acting "ascensional screws."

It is perhaps not quite correct to class this among exploded ideas, as it contravenes no physical law, and so is not impossible; but, in the sense of being a highly-impracticable system—that is, the most extravagant of power conceivable—it is a fallacy. As such, I may be rendering a service to some intending experimenters in warning them off it. Here, again, I have "been through the mill," which fact may add weight to my dissuasion. (See figs. 3, 4, and 5.) It may be borne in mind that the failures (arising from fallacious notions and methods, as well as other causes) are often more instructive than the successes.

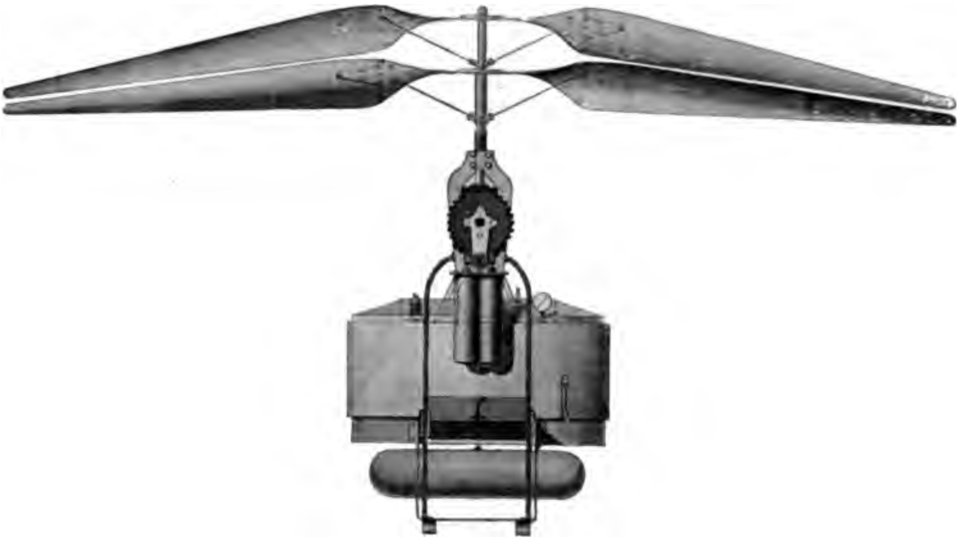


Fig. 3. Steam aerial machine with concentric (R. & L.) vertically acting ascensional screws (front view).

That man can ever fly by his *unaided* muscular powers—by this, of course, is to be understood *sustained* flight—is another and a rather widely-spread delusion. This is more particularly the case as regards using his arms to actuate wings, or other sustaining appliances. Apparatus has been devised at different times intended to be worked by the legs (see fig. 6), which, as we know, have a considerably larger allowance of power than the arms, but with all such apparatus hitherto tried the power resident in even these limbs has been found quite inadequate.

It will, I think, be scarcely necessary to remind the reader that the soaring and gliding experiments carried on of recent years by Lilienthal, Pilcher, Chanute, and Wright—which I have dealt with elsewhere—are not instances of man-flight, but quite distinct from it, the apparatus in all cases consisting of *fixed* gliding sustaining sur-

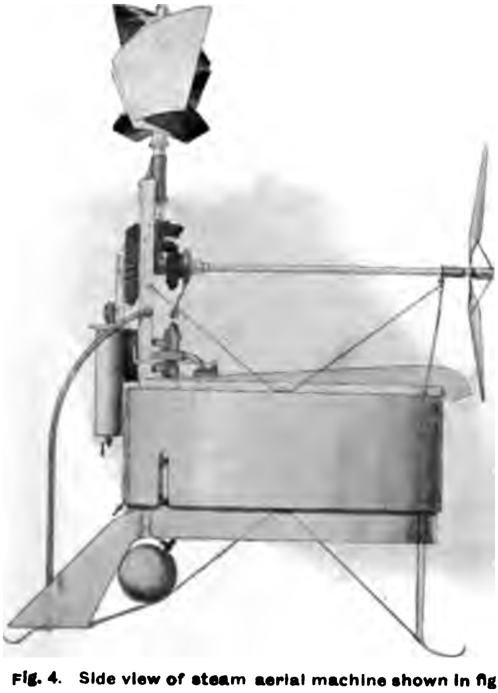


Fig. 4. Side view of steam aerial machine shown in fig. 3.

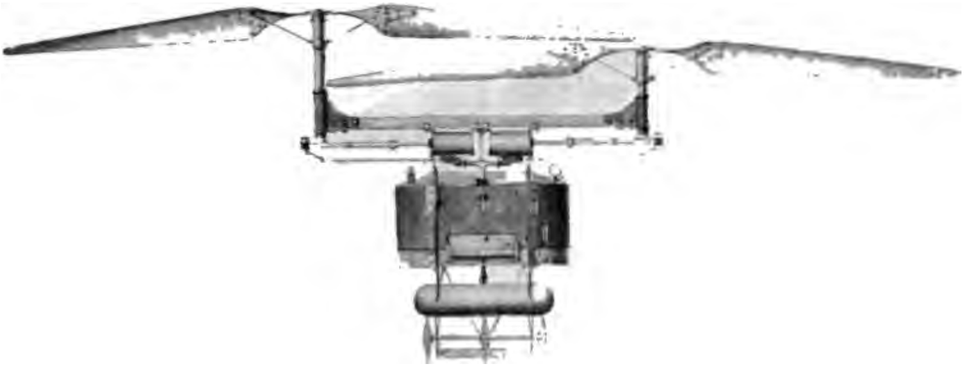


Fig. 5. Steam aerial machine fitted with vertically acting ascensional screws.

faces without movable wings or other propellers. In this demonstration the "trip" only lasts as long as the initial impulse gained by running ahead against a breeze and launching off a hill-side, the man first carrying the apparatus and then being in turn carried by it—to skim along in a more or less descending course, and (when all goes well) settling down gradually by parachutic action, to land safely some hundreds of feet distant from the starting point. The only muscular effort required of the passenger is in the alert shifting about of his limbs and body necessary to maintain the balance of the apparatus and to effect a safe landing. The course that has been followed by certain hare-brained enthusiasts (and they really deserve the epithet) of launching off a cliff, a tower, or other sheer eminence, or even cutting themselves adrift from beneath a balloon, is as wild and reckless as it is wholly unnecessary. Really one cannot sympathise with those who deliberately court and meet their death in this way, and, moreover, who thus help to bring ridicule on sane legitimate experiment. The unfortunate, ill-advised men Letur (in 1852) and De Groof (in 1874) pinned their faith and their lives to different, but equally impracticable, forms of parachute plus wings, by means of which, when cut adrift from beneath a balloon at high altitude, they fondly hoped to propel their respective apparatus in a horizontal course.

The tragedy that ensued in each case might have been easily anticipated and averted. This should be an impressive object lesson to those aspirants—and they must be described as foolhardly—who will persist in dropping to the earth from an unfairly-gained altitude, instead of honestly striving to design and construct apparatus that will rise from the earth or the water—not in a directly vertical course, as that we now know with true controllable and dirigible flight is impracticable for reasons previously stated, but with a preliminary launching run forward, either on the level or on a gentle down grade, until finally airborne. This is the legitimate course, that

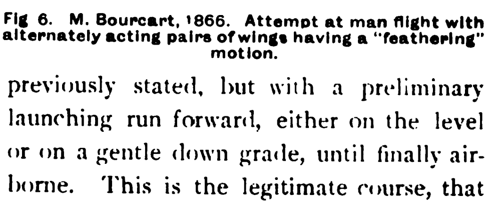


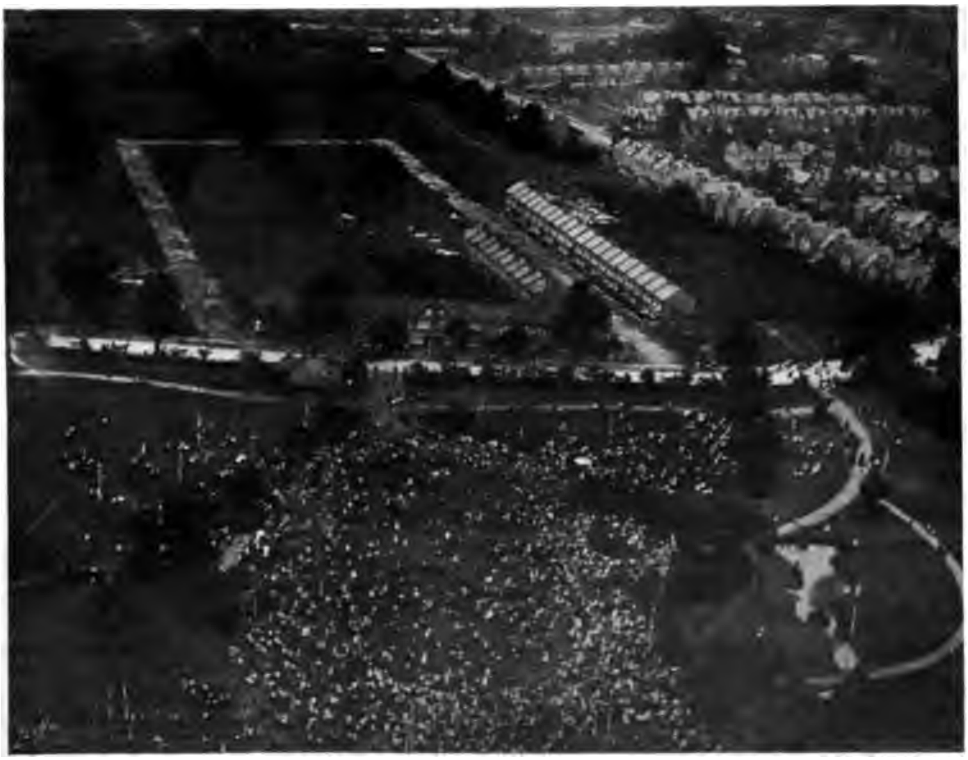
Fig 6. M. Bourcart, 1866. Attempt at man flight with alternately acting pairs of wings having a "feathering" motion.

which all the larger birds of flight have to follow, and which must inevitably distinguish the ultimate practicable aviator. With such apparatus and such a course, in making progressive trials and experiments with the earlier undeveloped forms, if a particular form be a failure it fails to rise, and as "he who is down need fear no fall," no fatal accident ensues, and the experimenter having exercised discretion lives to fly another day; whereas, if he had pursued the former reprehensible method, outraged gravitation would surely have claimed him for its own.

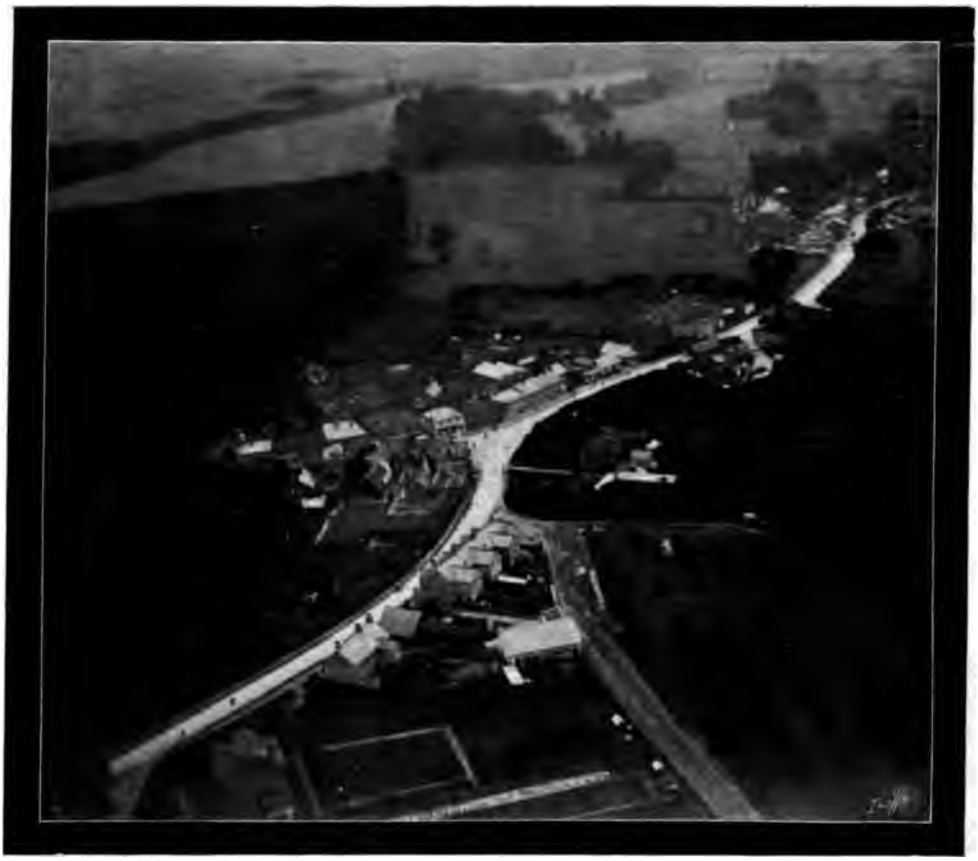
*(To be continued.)*

# Balloon Ascents by the Aeronautical Institute.

On Coronation Day the celebrations at Beckenham included a balloon ascent by M. Gaudron and Dr. Barton, members of the Aeronautical Institute and Club. The accompanying illustrations are from photographs taken from the balloon during its flight. The greatest height reached was 5,200 feet, but whenever a photograph was taken a partial descent was made for the purpose. They came to earth, after crossing the Straits of Dover, on a deserted portion of the French coast at Hemmes d'Oye, nine miles from Calais. The time was 9h. 20m., and it was quite



GENERAL VIEW OF THE RECREATION GROUND, BECKENHAM.
Photographed at a height of 500ft. The upturned faces of the people give the spotted appearance.

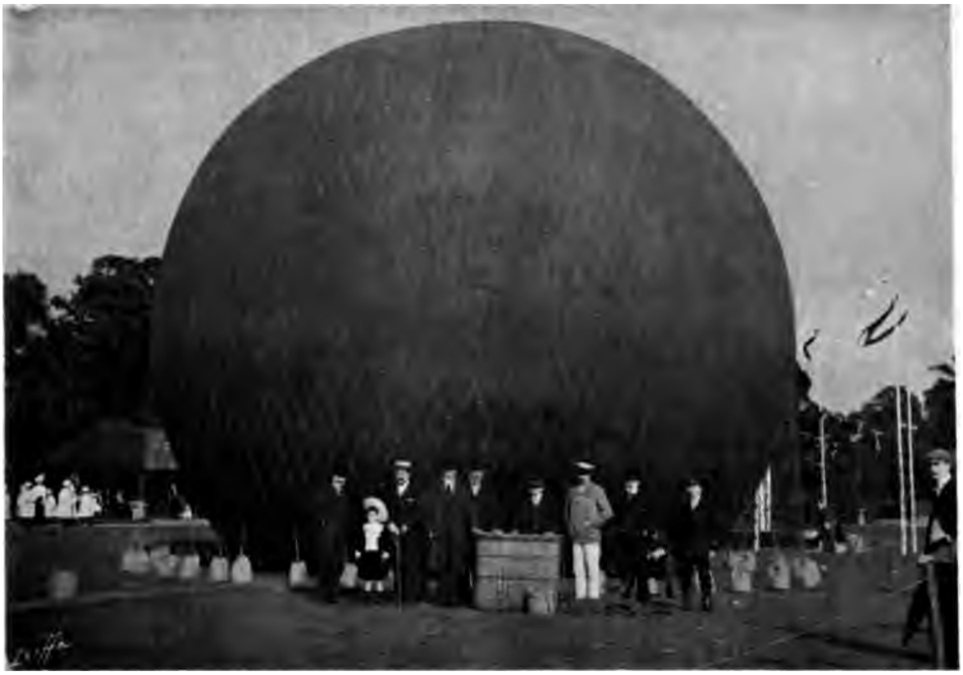


THE SEVENOAKS ROAD, WHERE IT PASSES THROUGH FARNBOROUGH, KENT.
Photographed at a height of 700ft.

lark. Some difficulty was experienced in landing, on account of the strong wind that was blowing at the time. Indeed, M. Gaudron, who has made several hundred ascents in his time, describes it as the worst landing he has ever experienced. Dr. Barton has created a record in that he crossed the Channel on his maiden balloon ascent.

By the kindness of M. Gaudron an instructional balloon ascent was arranged for the edification of the members of the Aeronautical Institute on August 20th at Beckenham. Besides M. Gaudron, who took charge of the balloon, there ascended Mr. O. C. Field (hon. secretary of the club) and Mr. R. McNair. The balloon descended at Rochester, and the aeronauts were back at Beckenham in the course of two hours. Several photographs reproduced in the present issue were taken on that occasion—some before starting, and others from the balloon itself.

M. Santos-Dumont is having a new air-ship built, in which he proposes to carry passengers around Paris and Versailles. The balloon will be egg-shaped, 75ft. long, and somewhat larger and more powerful than any of its predecessors. Accommodation will be provided for eight passengers, besides the crew of two, and it is stated that bookings have already been taken, although the air-ship is not likely to be ready for two months.



INSTRUCTIONAL ASCENT AT BECKENHAM, AUG. 20th.
Balloon partially inflated, group of club members in front (see page 162)

# The Late Dr. Otto Lilienthal.

(*See Frontispiece.*)

PROBABLY no practical experimenter in the field of elementary true flight has rendered such valuable service to that cause as the late Dr. Otto Lilienthal, of Grosse Lichterfelde, near Berlin.

His invaluable experiments demonstrated the possibilities and the limitations of a true aerial machine of practicable dimensions carrying intelligent control, *i.e.*, a human passenger.

These experiments were conducted mainly with motorless apparatus, but that is as it should be in the initiatory stage of true flight, of which Dr. Lilienthal was so untiring an exponent. A clever mechanical engineer and physicist, possessed, moreover, of great personal courage and perseverance—very highly essential qualifications—he was a man we could ill afford to lose.

There is consolation and much gain to us in the fact that before the lamented sacrifice of his life in 1897—through, it is to be feared, the relaxed caution and vigilance born of success—he had during the preceding two and a half years safely effected a host of very instructive and interesting demonstrations of absolutely free gliding flight—in all about two thousand flights.

Not only did Dr. Lilienthal effectually advance the problem in this way, but left on record a mass of valuable data, deduced from the foregoing, in contributions to the technical press.

# The Bicycle as an Accessory to True Flight.

BY SIDNEY H. HOLLANDS AND G. LACY HILLIER.

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*(Continued from page 111.)*

## PART II.—THE AIR-BORNE BICYCLE.

THE bicycle of to-day is in a sense always air-borne, in that the all-pervading pneumatic tyre interposes a continuous stratum of compressed air between the machine and the road. However, we scarcely need remark now that it is not in that sense we use the term herein.

By and by we may find it expedient to coin a neat adjective, analogous to the word amphibious, but to apply to the class of vehicles that we see looming in the near future, that we may now quite reasonably expect to be evolved: a vehicle at once adapted to travel terrestrially and aerially. At present, however, the above sub-heading appears to be the nearest approach to its true description available.

Attention has been given for centuries to the question of flight, but very few inventors have begun at the beginning, and it is as impossible to evolve a successful flying machine without a sound basis of preliminary *progressive* experiment to-day as it would have been to build a perfect safety bicycle of 1902 pattern in the year 1860.

The bicycle as perfected upon the racing path has done much outside the sport of cycling; the improvements in detail have been adapted to other uses. Ball bearings, single and double, in cages and free, were tested under the most careful observation, and may now be found fitted to many other vehicles and machines, particularly where it is desired to transmit power with a minimum loss from friction.

The propeller shaft of Santos-Dumont's "airship" is run in, and supported by, ball bearings of the cycle type. The cycle driving chain has been similarly improved; in short, every part has been carefully considered under conditions of actual work, with results that do not need to be particularised.

The history of the development of the bicycle in many ways parallels the lines of development which a flying machine heavier than air would follow, at least in the earlier stages, and the bicyclist would be a useful helper in this work.

The cycle provides a means whereby a greater rate of speed can be attained than in previous gliding-flight methods, and presents this further advantage, that, being a balanced machine, the behaviour of experimental aerial adjuncts at high speed could be carefully studied.

Even with the extra weight involved, and the extra surface presented to the air, it should be possible to attain a much greater speed than has ever been reached by a man running thus encumbered.

From the particulars given in Part I. of this series, relating to past experiments in gliding and soaring flight by other methods, certain points are made clear to the intelligent reader. Primarily, high speed is a necessity, and in a lesser degree has hitherto been attained by running on foot, towing, and by the aid of kites, the latter giving soaring results only.

Obviously, a man running with a flying machine that has adequate area of surface for sustentation of the total load at speeds within his reach, thus hampered, could attain but a moderate speed whilst carrying the apparatus and himself on foot against an air current either natural or induced, although he may in a measure reveal the behaviour of the apparatus; but it is a laborious method, and, moreover, is quite lacking in the positive steadiness of travel and freedom from involuntary sudden tilting of the apparatus which should characterise high speed aerial apparatus of much less area carried on a steadying wheelbase such as the bicycle affords.

If, however, the apparatus is towed, it is then allied to kite flying. As such, it is not free flight, and does not further advance the object now aimed at. Furthermore, we have to deal with the question of equipoise and consequent stability in the air-borne bicycle.

Professor Bell Pettigrew, in his very instructive work "Animal Locomotion," says: "The speed attained by man, although considerable, is not remarkable; it depends on a variety of circumstances, such as height, age, sex, and muscular energy of the individual, the nature of the surface to be passed over, and the resistance to forward motion due to the presence of air, whether still or moving. A reference to the human skeleton, particularly its inferior extremities, will explain why the speed should be moderate. . . . Another drawback to great speed in man, as distinguished from animals, is . . . part of the power which should move (serve as a motive power) . . . is dedicated to supporting the trunk."

Robert P. Scott, the American authority on cycling, in his excellent book "Cycling Art, Energy, and Locomotion," says: "*Apropos* of fundamental principles, what are the requirements needful for the most successful means of man-motor locomotion? In more homely phrase, how can a man, without calling upon the storage of energy other than that inherent in his own body, propel himself from place to place with the least amount of physical exertion? It is evident now that under very many circumstances the means provided us by the Creator for such purposes are not the most economical; that is to say, it has been found that, if we employ a medium through which to transmit our energy, the energy will be more economically expended in carrying our bodies from place to place than if we apply the force directly to the work, as Nature seemed to intend in presenting us with a pair of legs. . . . Why we have been able to thus improve upon Nature's device is not quite clear. Undoubtedly, however, there is some unnecessary friction in the leg method; it cannot be on account of impact with the air, because a man on a bicycle certainly catches as much air himself, in addition to that of the machine, as he would do in walking. Evidently, then, there must be more motion or extra friction, or both, in the body, in the leg method, than is really essential in conveying one over a good road.

"Probably the main cause of this friction is that the rider's body is supported differently; it requires less muscular strain to sit than to stand.

"We not only know this from experience, but it is proved by the fact that the temperature of the body is lower while sitting than while standing, also still lower when lying down, showing that less energy is being expended, and less muscle consumed. . . . The whole question of the advantages of the cycle method or wheel locomotion must resolve itself into one of reduction of organic friction, as shown by fatigue in the body. All organic friction, such as metallic friction in the machine and upon the road, must be finally overcome at the expense of organic friction due to the exercise of the muscles in man."

The primitive beginnings of the cycle are to be found in the "dandy-horse," or "Draisenne," of 1819 (fig. 1). This vehicle consisted of two wheels placed bicycle-wise, the front wheel being used to steer with, and a wooden backbone, across which the rider sat and propelled the machine by thrusting on the ground with his feet. Clumsy as was the "dandy-horse," it afforded opportunities for learning balance, which in due season—somewhat deferred it must be admitted—led up to the crank-driven velocipede, and those wonderful developments which have reached at length the motor bicycle stage.

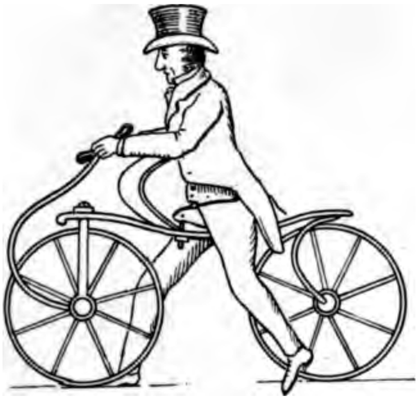


Fig. 1. The Dandy-horse, 1819.

Had there been no "dandy-horse," the later development would have been longer delayed.

As it is essential that the new aerial course of cycle experiment we now treat of, and propose to inaugurate, be strictly progressive, it behoves the experimenter in this field to restrain his ardour at first within comparatively modest limits, and to feel his way; he must not expect to leave *terra firma* and become wholly air-borne for some little time. Probably some weeks of daily experimenting must intervene, this time being devoted to the determination of the *minimum* total area of sustaining surface admissible; the angle of inclination of the component aerocurves of that surface that gives the maximum of efficiency in relation to the speed found to be attainable on the bicycle when fitted with, and to some extent retarded by, the apparatus of sustentation; also to the adjustment of position of the lifting surfaces for adequate aerial stability.

The "drift," *i.e.*, the horizontal air resistance to forward motion of the lifting apparatus, need not, and would not, be a formidable factor in this system, as the component aerocurves would preferably be set at a small positive angle with the horizon, and at low angles of inclination the ratio of "drift" to "lift" in suitably designed aerocurves is really very small. It should not be difficult to secure the co-operation of some well trained cyclists—a point not to be lost sight of, because energy and nerve would certainly be required in the preliminary stages of the experimental course. It may be said that even an averge cycle rider would have little of a special nature to learn in the management of a bicycle equipped with air-sustaining and gliding appliances when once the final adjustment of the lifting surfaces in relation to the centre of pressure had been effected, particularly as regards the maintenance of balance when air-borne. One of the imperative features of such a machine is ***automatic aerial stability***; the apparatus to be invariably so designed and attached to the bicycle as to possess this excellent quality.

The acrobatic performance, *i.e.*, the agile shifting about of the limbs and body of the rider in order to maintain the balance in air—imposing a ceaseless mental as well as physical tension—as necessarily practised by Lilienthal and Pilcher with their gliding apparatus, in which there was an absence of automatic stability, must be obviated in this new departure.

The extent to which the bicycle will be handicapped, so to speak, by the addition of aerial lifting and sustaining apparatus will, of course, depend mainly on the ratio of "lift" to "drift," as hereinbefore implied. Broadly speaking, the "drift" decreases with the reduction or acuteness of the angle of inclination of the aerocurves; but then aerocurves of different curvature and depth of concavity of under or lifting sides have different angles of maximum efficiency within rather wide limits, and reducing the angle of inclination demands a compensating increase of horizontal speed in order to attain the same amount of "lift" as before. While this is so, at the same time the attainment of that necessary acceleration is favoured by the decreased "drift" of the aerocurves when set at the acuter angle with the horizon. Given fairly efficient and adequate area of lifting surface, the relations of "lift," "drift," and speed adjust themselves automatically within certain limits.

Some advanced practical experiments in aero-dynamics made by Prof. S. P. Langley, of Washington, U.S.A., revealed the astounding fact—and it seems clearly to be a fact, although contrary to preconceived belief—that, with aerocurves of certain proportions, curvature, and inclination, the "drift," or forward resistance positively *decreases* with increase of speed, instead of increasing as the square of the velocity. This really startling result must evidently be due to the now fairly well-known aerial phenomenon "aspiration," which the special form of aerocurve favours. Theoretically, with infinite speed, infinitely small surface would suffice, but the object of the course of trials, as already intimated, is to find practically the smallest area of surface that will lift the added weight of the aviator and passenger, and the perfect adjustment of the angle of inclination to the speed.

Calculations will help us little or nothing in these preliminaries, particularly as we are not dealing with aeroplanes, but aerocurves (fig. 2), about which mathematicians can as yet tell us so little of a trustworthy character. It may, indeed, be said that all we know about the quality of aerocurves has been learnt from practical experiment. Some of such experiments with aerocurves at low angles and very high velocity, just previously referred to, as conducted by Prof. Langley with such startling results, have—rather naturally, perhaps—been regarded with considerable incredulity by the mathematicians, as also about the proven fact "aspiration."

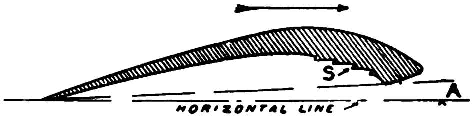


Fig. 2. Cross section of single aerocurve of very efficient form, serrated at S, and at small positive angle A.

By the way, a lucid definition of the latter phenomenon has been given by Mr. Octave Chanute, C.E., of Chicago, which may be fitly quoted here, viz., "Aspiration is the act of flying in the face of the wind without using other power than that furnished by the wind itself."

We know by recorded past experiment the approximate necessary area of aerocurve surface for a given weight, speed, and angle; but we hold that in this special course it would be well to proceed as if we did not, but, of course, exercising judgment and common sense. It is essentially matter for experiment and evolution, and we are convinced that it is entirely futile to approach it mathematically.

In this new application of the bicycle we scarcely hope to attain a speed much exceeding fifteen miles per hour. That speed, we roughly estimate, should be found, however, sufficient for the purposes of these experiments, even when not supplemented by a head wind. The gliding experimenters on foot had to invoke the aid of a very considerable head breeze, and to supplement it by running as well as they could in order to get a lift. Now a man trotting along and carrying a large and cumbrous form of lifting surface in a stiff breeze has no effectual means of steadying it, and so ensuring a fair launch off every time.

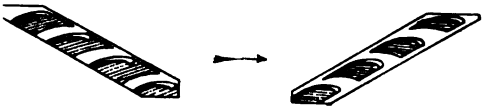


**Fig. 3. Cross section of detached sets of aerocurves (Holland's "stepped" system). These are inclined at the diedral angle of 150° transversely.**

Here, again, our proposed cycling system scores, both as a very effectual means of steadying the apparatus, and in that apparatus of aerial sustentation consisting of much smaller—because more efficient—and more compactly arranged surfaces (fig. 3), for which form and arrangement one of the present writers claims entire originality.

First, then, our idea is to fit to a safety racing bicycle a small gliding aviator of a design specially adapted to its environment.

In proportioning the lifting surface for the pioneer machine, we should not look for guidance to the areas employed by the past exponents of gliding flight, as we shall be dealing with a different type and arrangement of surfaces from those, being of proved superior efficiency, and, therefore, presumably of proportionately less necessary area. Lilienthal employed an area of 151 square feet for a total weight of 143 lbs. In Chanute's gliding apparatus the proportion was 167 square feet for a weight of 182 lbs., the former being in the ratio of .95 square foot per pound, and the latter gives .91 square foot per pound. With our proposed type of apparatus we estimate that it will, for a start, approximate sufficiently to final requirements, if we allow a proportion of .64 square foot of aerocurve surface per pound of total weight, so that if our total weight is 166 lbs., which is about what it would be with a 130 lbs. man, a total area of 106 square feet would suffice for the

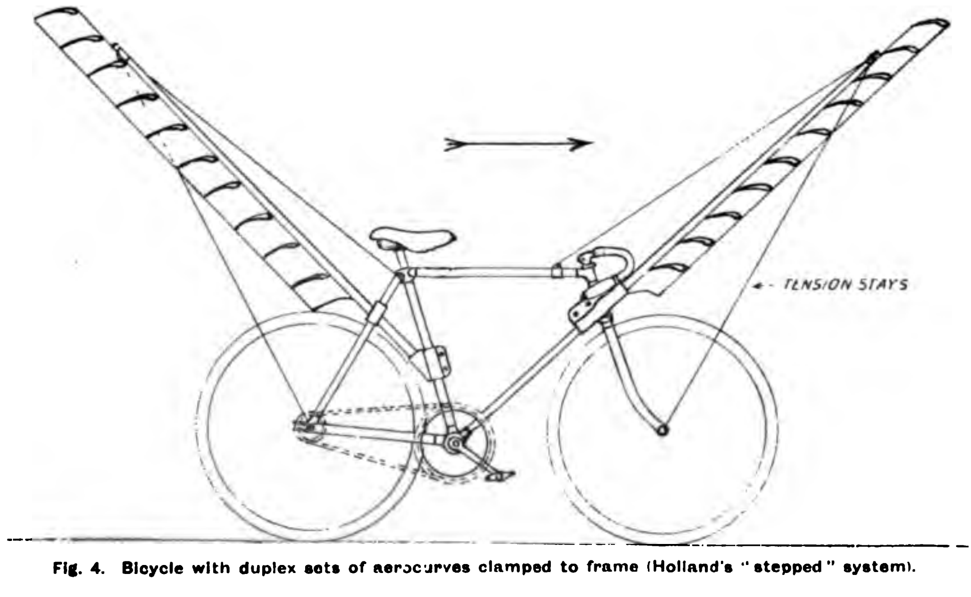


**Fig. 4. Bicycle with duplex sets of aerocurves clamped to frame (Holland's "stepped" system).**

initial trial. This is assuming a speed of fifteen miles per hour only, which quite probably can be exceeded; if this prove to be the case, so much the better. Thus, if eighteen miles per hour is reached, the necessary area will be reduced to seventy-three square feet, and this reduction of surface, by reducing the resistance, will admit of a further increase of speed.

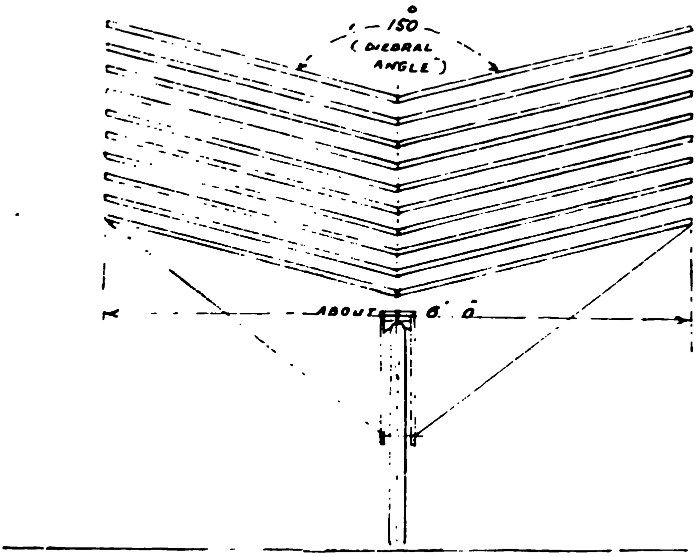


**Fig. 5. Transverse view (diagrammatic).**

The apparatus adapted to be clamped to a bicycle frame would take the general form of fig. 4. This applies to the earlier undeveloped experiments.

At a more advanced stage we would propose to construct a light bicycle of special design, making any improvements or modifications that may be suggested by the previous trials.

The special type used will preferably follow the lines of the "Pedersen" light bicycle (see fig. 6).

With this exceedingly light type the weight of the bicycle need not exceed 17 lbs. The wheels would not be larger than 22in. diameter. A strong, stiff tube or tubes A B C would have a steel wire truss at B D C, and stays of similar wire at E F G. The seat tube J might be pivoted at H to admit of adjustment of centre of

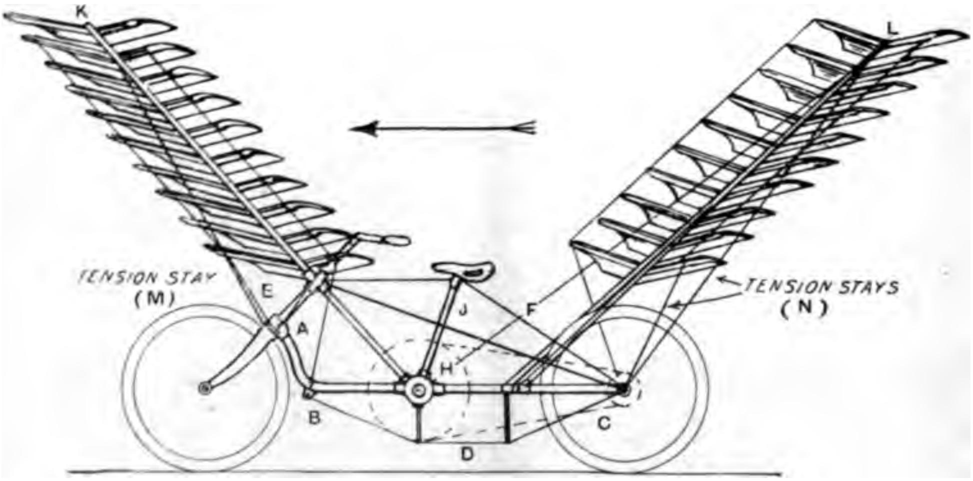


**Fig. 6. Pedersen type of bicycle (modified), fitted with "stepped" system of aerocurves. Lateral spread of aerocurves = about six feet.**

gravity, *i.e.*, by longitudinal shifting of the saddle either backwards or forwards, which is fixed when the best position has been determined.

This means of adjustment, however, is not imperative, and may be found quite dispensable.

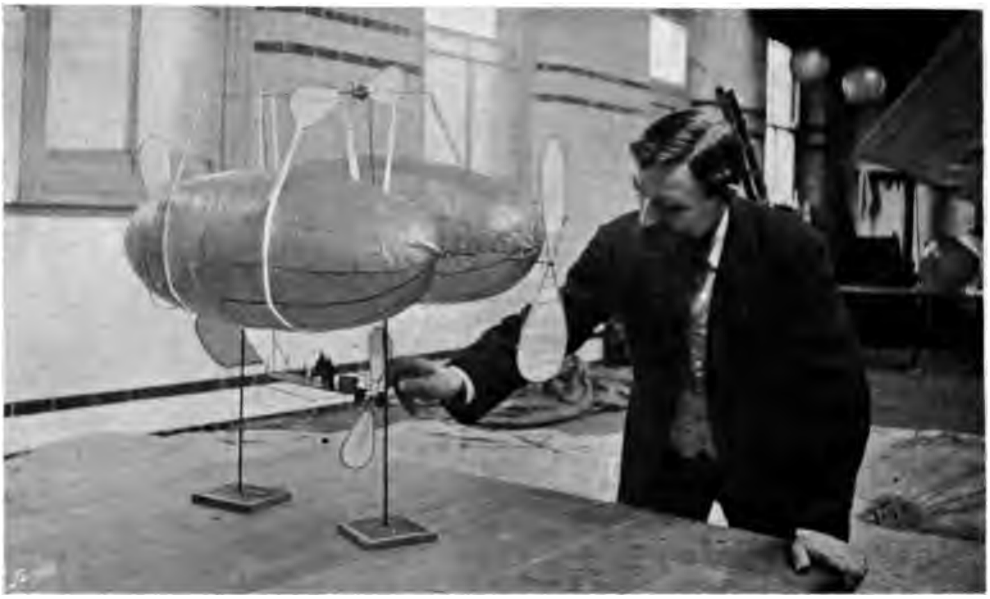
Light and stiff tube booms K and L would spring from the frame tubes at front and rear. These respectively will carry the front and rear sets of lifting aerocurves, and are stayed by tension wires at M and N.

Doubtless, as with the abstract bicycle, the earlier essays would be unsatisfactory; but, just as many men taught themselves unassisted to ride the bicycle, so some of the experimenters with the cycle aviator would learn how to control and balance it under speed. The fact that model aviators have really flown evenly for considerable distances shows that there would be little difficulty in keeping the arrangement as fitted to a bicycle " on an even keel."

*(To be continued.)*

# Mr. L. J. Andersen's Airship.

MR. L. J. ANDERSEN, of Woodford Green, Essex, exhibited at the last meeting of the Aeronautical Institute and Club, a model of an airship which he had invented, the construction and general arrangement of which will be seen on reference to the accompanying illustration. He explained that, having watched the development of airships for the past two years, he favoured the adoption of cigar-shaped twin balloons for lifting purposes. By this arrangement the air disturbed by the main propeller in front would pass between the two balloons, and not cause any obstruction. There were four propellers, as shown below.



THE ANDERSEN AIRSHIP MODEL.

The principal propeller, placed in front, was for pulling the balloon along in a horizontal direction, while the others were brought into use when it was desired to move upward or downward, as the case might be, and the upward and downward movement was also regulated by the disposition of weights. The front propellers, he said, would be about sixteen feet from tip to tip—eight feet each arm; the top ones would be smaller, and they would all be worked by a motor. The balloons were carried on a hexagonal frame, and inflated with coal gas; they would be of a capacity of about 80,000 cubic feet, but with lighter gas the balloons could be smaller. He suggested that the motive power should be transmitted by bands or wire rope to the propellers. He had only been engaged on the machine about eight months, so that he fully expected a good deal of criticism. The chief points were forward movement by propellers of eight or ten miles an hour, and rudder steering.

**INSTRUCTIONAL ASCENT AT BECKENHAM, AUG. 20th.**
**Balloon laid out ready for inflation** (see page 162).

The President (Dr. Barton) said there were some very good points in the machine. To have the force equalised and the chief force at the centre of greatest resistance were the desiderata of all airships, and the idea of equalising the propelling power above and below was also good. The transmission should be by gear or chains, and not by any material which would absorb moisture.

Mr. Blanchard pointed out the lack of detail in Mr. Andersen's description of his invention.

Mr. Andersen explained that he had purposely abstained from entering into details, as these could be worked out later.

Mr. R. McNair thought that with twin balloons it would be found that the rush of air going between them would cause the framework to be severely strained. Some secure means ought therefore to be taken to fasten the balloons within the frame. He suggested that the balloons should be entirely enveloped in netting. He thought the bottom propeller could be dispensed with, and perhaps also the upper one. (Laughter.)

Mr. Gaudron pointed out that there would be a danger of the two balloons knocking against each other. He thought Mr. Andersen would have to enclose each balloon in a rigid framework.

Mr. Sénécal said the weight of the machinery on the platform beneath the balloons would tend to bring them together, and he asked what were the opposite forces to prevent them doing that?

Mr. Andersen replied that each balloon would be separately suspended from the framework on both sides and attached to the hexagonal frame, which would keep them six feet apart.

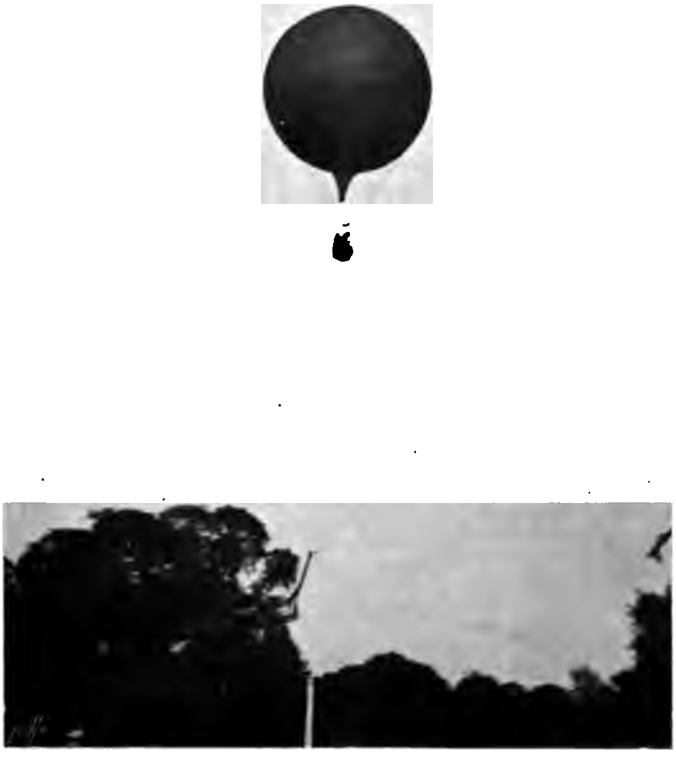
Mr. Field said he was inclined to encourage Mr. Andersen to continue with his design, as it had several points in its favour. One was the amount of surface in the propellers. The propelling power was the chief thing they had to economise, and he thought a large amount of surface in the propellers meant a saving of slip, which in other words was an economy of horse-power. They often lost about two-thirds of their power from simple slip, and he thought the model before them showed that that point had been taken into consideration. He did not approve of the positions of all the propellers; the lower one would cut the ground when it descended to earth. The great principle embodied appeared to him to be the balancing of the driving power in the correct horizontal direction, neither below nor above the centre of gravity, though the centre of gravity was rather low.

**INSTRUCTIONAL ASCENT AT BECKENHAM, AUG. 20th.**
The final preparations for the ascent (see page 102).

Mr. Fox made some remarks on the

general principles of balloon construction, but, as they were not specially applicable to the model before the meeting, the President asked him to reserve them for some future occasion.

On the proposition of Mr. McNair, seconded by Mr. Gaudron, Mr. Andersen was warmly thanked for his contribution, and the President urged him to make a larger model to scale and bring it before the institute again for testing.



**INSTRUCTIONAL ASCENT AT BECKENHAM, AUG. 20th.**
**Balloon leaving the ground** (see page 162.)

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The motor which drives the Mellins airship is a Simms as used for motor cars.

## The Early Days.

It was in 1783 that the Montgolfiers and others of Paris began to make ascents, and the news of their exploits created a French invasion scare on this side of the Channel. It was in the year 1784 that the first ascent was made in England by one Lunardi, who went up from the Artillery Ground at Moorfields. The members of the City Artillery Company were under arms to protect the balloon from the mob, which had an even greater objection to new ideas and things beyond its comprehension than the mob of to-day. Lunardi first came down at North Mimms, quite near to the residence of the ex-Prime Minister. The aeronaut then made another ascent and came down near Ware. He had much difficulty in inducing some labourers to assist him to anchor. In their simplicity they feared to approach the monster. However, an angel in the form of a young woman "rushed in" and took hold of the rope, and Lunardi was rescued.

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The German War Office has been making mysterious trials with a new airship invented by an engineer at the Spandau military workshops. The inventor has worked for years on its construction, and it is said that his machine imitates the flight of a bird, and that it is propelled in a way never yet attempted by other inventors.

# Air Flapping Machines and Personal Flight.

LECTURE BY MR. J. T. BLANCHARD.

A MEETING was held of the Aeronautical Institute and Club at St. Bride's Foundation Institute on August 1st, Dr. Barton in the chair, to hear a lecture by Mr. J. T. Blanchard on "Air Flapping Machines and Personal Flight."

The Chairman, in introducing the lecturer, said Mr. Blanchard had not been very much before the public personally, but, as a writer, he was well known, having written articles on aeronautical subjects in various reviews.

Mr. Blanchard said his first duty was to acknowledge the courtesy which that institute and club had done him by inviting him to address them, and his second duty was to offer a few personal explanations. It would be necessary to pass in review the different inventions which came within the scope of the lecture, but let it not be supposed that he was animated by any bias, spite, or ill feeling against any inventor whatsoever. On the contrary, so far from such feeling existing in his mind, he entertained nought but the fullest regard towards those who worked in this field of research in proportion to their earnestness, competency, and devotion to the cause. On the other hand, let it not be thought that he had any pet scheme of his own, or of any friend, relative, or acquaintance to advocate; he was actuated solely by a desire to further the movement. This being said, he would premise by a few generalities.

### TWO SCHOOLS OF AERONAUTICS.

Aeronautics, or, rather, their followers, were divided into two main classes—namely, those who believed in the principle of buoyancy, and those who believed in the principle of mechanical flight, *i.e.*, of operating bodies heavier than air. The second class were called aviators, and their system was known as aviation, derived from the Latin *avis*, bird. It went without saying that the class of machines with which they were dealing, namely, flapping machines, came under the second category. It would be his aim to see whether some mutual meeting ground might not be found between these two parties, for it was well known that there was not only no friendship, but rather bitter opposition, between these two factions. He deemed it necessary in dealing with this question to recapitulate briefly those authorities who had made their mark in the field of aviation. In America there were Prof. Langley, Octave Chanute, Mewes, and Rotch; in the United Kingdom, Sir Hiram Maxim, Mr. Pilcher, and the older ones, just to mention a few, Henson, Wenham, Pettigrew, and Stringfellow; in Australia, Professor Hargrave; in Germany, Lilienthal and Buttenstedt; in France, Marey Monge, Peneau (whose automatic toy, the butterfly, was well known), Hureau de Villeneuve, etc.; in Austria, Kress, Professor Wellner, Hoernes, Ritter van Lössl, etc.; in Italy, Forlanini, Count Carelli (Turin); in Russia, Danilewsky, who, however, invented a system composed partly of aeroplanes and partly of a buoyancy vessel.

### AIR-FLAPPING MACHINES.

Coming now to the subject of the evening, a great many patents, the lecturer said, had been taken out for apparatus designed to be used as flapping machines. He had not examined them all, and would not set forth in detail those he had seen. They were in the main recapitulations having certain features in common, but varying in particulars such as in the kind or power of the driving engine, the arrangement, number, and shape of the flappers, and there was likewise a combination of different valves which were inserted in the flappers. He therefore thought it best to select one apparatus coming under this head which he considered typical, being neither better nor worse than most of them, and which was exhibited in the accompanying diagram. The machine was invented by Quentin and Guattari (B. patent No. 3,872, of February 27th, 1892), and the drawings which he exhibited were taken from the original patent specification. It would be seen that the machine was composed in the main of a vertical frame, which might be either round or oblong, or parallel, and which contained within it a motor. That motor might be driven by any kind of agent—steam, gasoline, benzoline, or compressed air, and the motor was reciprocating. These inventors used a gasoline engine, because it did not require a boiler—such an engine as was used in automobiles, with two cylinders side by side. A car carrying a passenger was roughly indicated. The engine, by means of connecting rods, operated the flappers, which were superimposed one above the other. The movement of the engine was transmitted direct to the flappers in an up

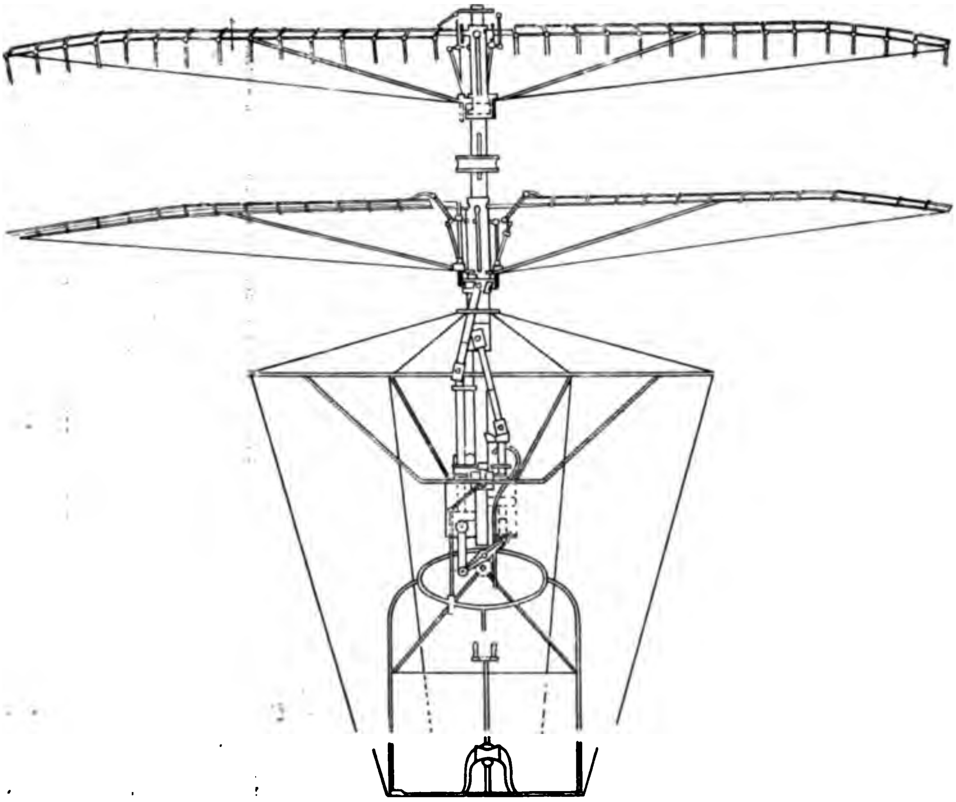


Fig. 1.

and down direction, exactly as the piston worked, and the pistons themselves were so arranged that one flapper—the upper one, for instance—received the upward movement, while the other received the downward movement. Otherwise, for obvious reasons, the machine would fall. These flappers were provided on their upper surface with valves which opened on the upward, and closed on the downward, stroke, causing a compression of the air, and by that means raised the whole aerial machine. The next figure showed the apparatus when it was intended to be used also as a kind of soaring engine. It was then proposed by the inventors to inflect the vertical beam which connected the engine, so that the flappers, being suitably inclined, would support the machine in an ascending or descending plane. With regard to the merits of these machines, it was hard, if not impossible, to speak, as none of them had ever taken the field—that was to say, the air—(laughter)—therefore positive data were wanting. It was no doubt not difficult to produce long algebraical equations and mathematical formulæ to prove that certain kinds of flappers were theoretically better than others, and gave so much higher lifting power. This kind of argumentation

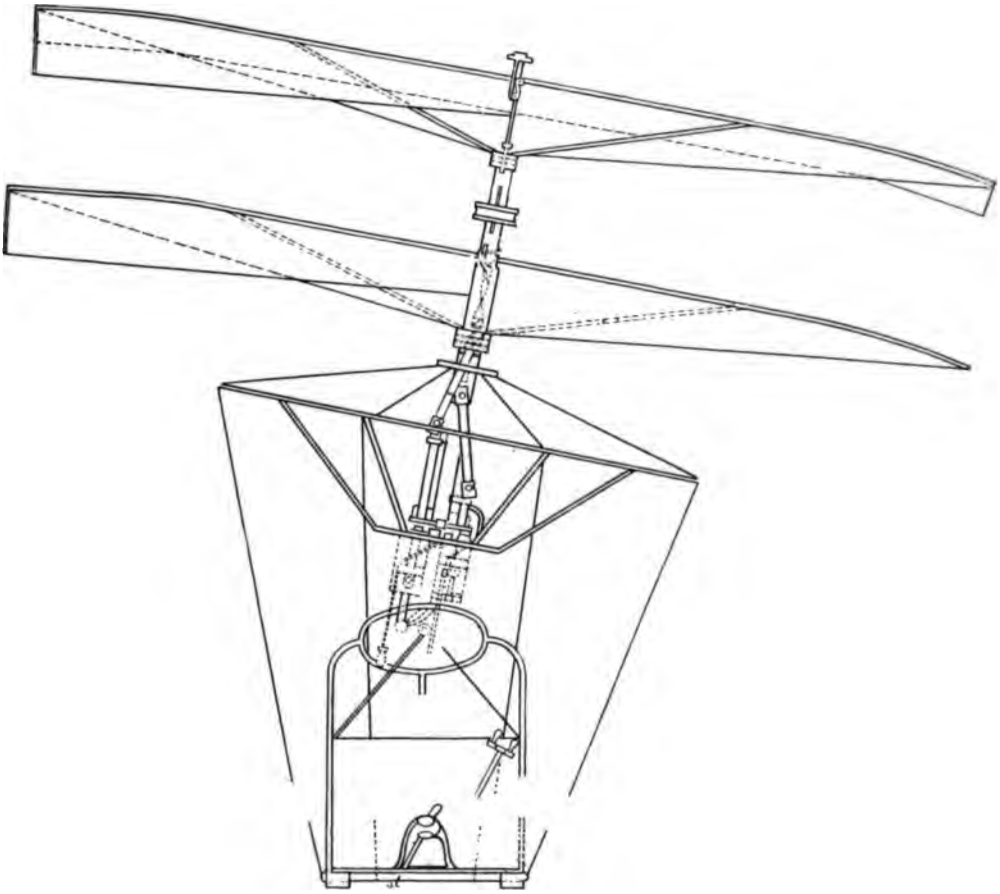


Fig. 2.

would not carry much weight with the practical aeronaut. Mathematics, like statistics, could be made to prove almost anything within certain limits; but an ounce of practice was worth more than a pound or a hundredweight of theory, yet the ounce of practice had never been forthcoming.

### DEMERITS OF THE MACHINES.

Turning to the debit side of the account, and examining the demerits of these machines, they were on safer ground. First of all, this kind of machine did not make provision for buoyancy. Another point was that, if they were to place this kind of machine, together with an ordinary balloon, or an airship of the composite pattern, on level open ground, under equality of atmospheric conditions, they would find it would not have such an easy ascent as either of the others, for reasons they would see presently. Now, supposing lack of buoyancy to be no defect; supposing these machines had an equally easy ascent with the others; supposing a power engine could be provided light enough for the purpose; supposing that the arrangement, shape, and dimensions of the flappers were proportionate to the weight to be carried; that the number of pulsations per minute was sufficient, and supposing that no breakdowns occurred in actual flight—a contingency which it was never safe to reckon upon: supposing all this, even then this kind of machine could not be recommended to the practical aeronaut, on account of its lack of stability when coming to the ground. There were in every aerial journey three stages to be considered—(1) the ascent, (2) the period of flight, and (3) the period of descent or coming to the ground. With regard to the ascent, if they had fair level open ground, and if the atmospheric conditions were normally fair, there was, generally speaking, little difficulty and less risk in making an ascent; there was less difficulty and risk in the flight itself, faultless design and construction of an airship and competent management being given, but where the difficulty and the risk came in was in the third period, namely, that of descent. No experienced aeronaut would deny this. Aeronautical records gave a sad testimony to the fact; and in support of this contention the lecturer cited the fate of Mr. Powell, M.P., who in trying to effect a descent near the seashore was blown out to sea and never heard of again; of Lieut.-Col. Templer, of the Royal Balloon Corps, and others who had been baffled when trying to make descents under untoward circumstances.

**INSTRUCTIONAL ASCENT AT BECKENHAM, AUG. 20th.**

**View of spectators in the grounds immediately after leaving earth.**

(See page 162.)

### Atmospheric Currents.

These instances proved abundantly that the third stage was the most critical, and that the contingency would apply to any airship. It would naturally be asked, what made these conditions so trying? It was obviously the state of the atmosphere—the airship acting on and being acted upon by the conditions of the atmosphere at the time existing. That was a very important and vital matter to the aeronaut. On observing the conditions of the atmosphere, it would be seen that there were two kinds of atmospheric currents—those that existed at high altitudes and those that existed at low altitudes. The former were equal, and possessed of uniform strength and direction; they were undisturbed. It was only at night that these elevated atmospheric currents, in consequence of the cooling of the earth, became denser and heavier, and sank towards the earth, thus meeting with and sweeping over high mountain ranges. When these upper currents became caught in mountain chains — entrapped or engulfed in their spurs and ridges and valleys — a circular motion was set up which resulted in eddies and whirlpools, thus causing local or low-lying irregular atmospheric currents. There was another far more potent cause for these local or low-lying atmospheric eccentricities; or, rather, there was a three-fold set of causes. First of all, they had to consider the irregularities of the earth's crust; secondly, the diversified covering of the earth's surface; and thirdly, the rays of the sun or radiation. These three causes acted constantly; they acted and reacted upon each other in various ways. When one observed the surface of the globe, one could not fail to notice its great variety — lowlands, far stretching plains, swamp, and morass alternating with each other. These again vied with hilly stretches, and the hilly stretches were relieved by mountainous districts with here and there mighty giants like the Himalayas, which raised their snow-clad summits above the clouds. Over all, the central orb of day shed its glorious rays—not only with different, but with diametrically opposite effect in different places. That was to say, the sun caused in one locality columns of air to ascend, while it caused in another, often closely adjoining, locality columns of air to descend. To illustrate his meaning, let them suppose first a barren stony tableland devoid of vegetation. All day long the sun's rays beat down upon it, the ground became heated, and threw back the heat so that the air became expanded,

**INSTRUCTIONAL ASCENT AT BECKENHAM, AUG. 20th.**
**Photograph taken from the balloon when nearing Bromley, showing Shortlands Railway Station (see page 162).**

and columns of heated air rose from the tableland all day long. Now, in another often contiguous locality he would suppose a narrow gorge or ravine covered with luxuriant tropical vegetation. Here the sun's rays did not reach the ground, or penetrate the jungle. It was only the tree-tops that were bathed by the sun's rays. Seeing that the tree-tops and the topmost boughs which were covered with millions of leaves were charged with moisture, these naturally, under the influence of the sun's rays, were made to perspire, that is, to evaporate. The evaporation was accompanied by cooling, so that as the air became heavier and denser, it contracted, and the superincumbent and adjoining atmospheric layers were sucked in, as it were, towards that foliage-clad gorge or luxuriant ravine, and a column of descending air was formed. This topographical configuration which he had endeavoured to set before them was not an uncommon or far-fetched one; it was, on the contrary, most common. It occurred in thousands of spots all over the globe, as they could easily imagine, and that being so, it followed naturally that the aeronaut, in coming down, was most likely to meet with the results of such topographical configurations, and have to bear the brunt of them. When two currents met each other in opposite directions, they fought a battle. There was a jostle and a jumble, they overlapped and encroached upon each other, they set up eddying currents and whirlpools, of which the aeronaut had so much reason to be afraid. These two columns of respectively ascending and descending air were not, if viewed in a horizontal section, in an ideal plane; they were not bounded by regular surfaces; they were not round, elliptical, hexagonal, or polygonal. They were most irregular, making, as it were, promontories, projections, indents, bays and convolutions, nooks and corners of every kind, thus offering advantages to the mutually striving currents to battle with each other, and giving them greater vantage ground, this irregular outline being, of course, in conformity with the irregularity of the ground beneath.

INSTRUCTIONAL ASCENT AT BECKENHAM, AUG. 20th.
Photograph taken from the balloon over Bromley, Kent (see page 162.)

### A LESSON FROM THE BIRD.

The bird—here he (the lecturer) might be permitted to recapitulate what he had said on a former occasion—did not fear these gusts and squalls of wind, as the professional aeronaut had to fear them. The bird hailed them with pleasure, and welcomed them. To the bird these gusts and squalls and eddying currents were most valuable helps. In this connection he strongly deprecated any view which extolled man as the crown of creation. He distinctly and fearlessly said that man had a great deal to learn from animals, and that animals, generally speaking, far excelled man in their quickness of perception of nature's inner warnings; that they surpassed man very often in their resourcefulness and their delicacy of touch. This was illustrated by the bird. The bird when on the wing felt these gusts and squalls, and even slight puffs of wind, because it was an exceedingly sensitive creature, every feather of its wing quivering with nervousness and animation; and, so far from avoiding or fearing gusts of wind, it took advantage of them. They were very valuable, because every little puff of wind represented an element of compression, very minute and fleeting no doubt, yet every such element meant sustentation or sustaining power. In this way, therefore, there was furnished to the bird whenever it turned in the air to meet these gusts of wind—backward or forward, sideways, right or left—an air cushion, on which it rode with comfort, ease, and safety. Therefore, he said, the aerial machine should do the same. In its operation man had to learn from the bird—to copy the bird; the aerial machine would have to become a feeling, sensitive machine; when operating it man would have to forestall and foresee the puffs of wind—though, perhaps, he might not be able to cope with gusts that came with terrific force. The aeronaut, when called upon to descend in a given locality in squally weather, must command an airship so constructed and designed as to forestall these gusts and squalls. The airship must be able to meet them by anticipation, and right itself by its own automatic action, so as to maintain an even keel.

### THE GREAT DEFECT.

Did air-flapping machines do that? They could not do it. They were not only practically powerless to withstand the gusts and squalls of wind; they were not only practically non-sentient, but, on the other hand, they even invited destruction and courted disaster. To make the matter clearer, he appealed to their imagination. Suppose a topographical configuration of a barren stony tableland such as he had set before them was in contiguity to a valley or ravine covered with dense vegetation. The ascending column of hot air would be pass-

**INSTRUCTIONAL ASCENT AT BECKENHAM, AUG. 20th.**

View over Beckenham (see page 162).

ing and rushing by the descending column of cold air. Imagine an aeronaut flying over that barren stony tableland, and saying to himself, "Here is a good spot to come down upon over this level country; there are no impediments or obstacles." All very nice and plausible, but since no aeronaut could ever decide the exact spot on which he was going to alight within a couple of hundred yards or so, it might happen that his airship would descend on the border line, where those two opposite air-columns met. What would happen if the airship came down on that border line? It was clear that one half of the wing, which by hypothesis he would suppose to be the left-hand one, and which he would also suppose to be about thirty feet in length, would be in the ascending column of air, and the other half would be caught in the descending current. What was the consequence? The turning of the airship upside down, capsizing it, and throwing it to destruction. He did not say this would happen, but it might happen, although it would be guarded against and counteracted by the centre of gravity being placed very low, as it properly should be. But for all that, if two gusts or squalls came with exceptional violence, the machine would run a very good risk of being capsized and sent to destruction. Before dismissing this point, he would like to say that aerial navigation by means of steerable airships was a very different matter from aerial navigation by means of globular balloons. In the former case there was a self-impulsive and directing power, whilst in the latter case the balloon was merely a soap bubble floating along with the breeze. This fact was an important one, and compelled the aeronaut, however expert he might be, when he desired to handle a steerable airship, to learn his trade practically over again. He had to learn to conform himself to the new requirements and the new set of conditions. If he did not he would find himself beset with difficulty, inconvenience, and possibly disaster.

[The second portion of the lecture, namely, that dealing with "Personal Flight," will be given in our next issue.—Ed.]

## Mr. Stanley Spencer's Success.

On Friday, 19th September, Mr. Stanley Spencer, of the firm of C. G. Spencer and Sons, aeronautical experts, Highbury, performed a notable journey on Mellin's new airship, which we illustrated and described in our last issue. Starting from the Crystal Palace, Sydenham (the weather conditions being favourable), he navigated his machine over Tulse Hill, Streatham, Clapham Common, on to Chelsea, Wormwood Scrubs, and finally landed at Eastcote, Harrow — a distance of nearly twenty miles. At the conclusion of his journey he despatched the following message to his firm:

> "Aeronaut, London.—Splendid descent, Eastcote, near Harrow. Wait for me before arranging conveyance."

As we go to press very few particulars are to hand of Mr. Spencer's feat, and we are unable to state whether from a really practical point of view he has surpassed the performances of Santos-Dumont; there is no doubt, however, that he has accomplished the longest journey that has been made in mid-air by a self-propelled airship.

Sixty miles in sixty minutes was the speed of travelling made by Mr. Spencer, the aeronaut, in a balloon with which he ascended at Morley, Yorkshire, and came to earth near Thirsk.

# An Amateur's Ideas on the Problem of Flying.

BY THE REV. E. RUST, M.A., B.D.

IT is some ten years ago since certain ideas occurred to me as the result of a partial study of the subject of flying. Then and subsequently I endeavoured to communicate those ideas to people who would be willing and able to take them up, amongst others to the late Lord Armstrong, but in every case without success, and even with the apparent result referred to by Mr. Sidney Hollands in your last issue, of "imperilling my reputation for sanity," and with the more pressing danger of involving myself in expenses, which would have been beyond my somewhat limited means.

With your kind permission I propose now to publish these ideas through the medium of your valuable magazine, hoping that they will be there accorded a more favourable reception than they have yet received.

My principal proposals are briefly the following:

(1.) The flying machine of the future must be supported in the air entirely by its own energy, and not by being attached to a body lighter than air, or to an aeroplane.

(2.) The flying machine must be amphibious to air and water, that is, with a boat or ship-shaped sub-structure, so as to rest upon the water, or to travel along its surface, as well as through the air.

(3.) The flying machine must be lifted and propelled by perfect feathering paddles, consisting of four fans so designed as to turn their full area to the air in their downward and backward sweep, and their edge to the air in their upward and forward sweep.

(4.) The wing area extended, and velocity of revolution, must be made commensurate with that extended and used by a typical flying bird.

Remarks on the above proposals:

(1.) A flying ship propelled and maintained in air entirely by energy is only in accordance with the pattern universally set by nature. The attempt to make a flying machine lighter than air, or a heavy machine raised in air by the lifting force of hydrogen gas, is doomed to failure. Count Zeppelin and M. Santos-Dumont have probably carried the experiment in that direction to its utmost possible limit, and are still far from success, practically as far as M. Giffard a generation ago was. I say it with all respect for the pluck and devotion of these two gentlemen, and not without regret, having regard to their most meritorious efforts.

(2.) The experiments of Mr. Maxim, of M. Santos-Dumont, Count Zeppelin, and others have distinctly proved that the problem to be solved is not only how to make a machine that will fly, but how to make that machine also leave the ground and alight upon it again, not only without injury, but also without danger. The problem, as regards leaving, and alighting upon, *terra firma*, remains unsolved as far as I am concerned, but my proposal is to use the intermediate element — water. The flying machine of the future must have the keel or hull of an ordinary vessel. This might be built of light steel, or of aluminium plating on a steel frame, sloping from about amidships to the bow, with a smooth convex surface, so as to rise in the water when driven at speed. Three pairs of paddle wheels on the deck level would be revolved by a light marine engine. The supply of water to the boilers could be frequently renewed by pumping from the sea when afloat, or by projecting a feed pipe into the water when skimming over its surface. The engine power would be large in proportion to the size and weight of the vessel, so that even when afloat the vessel would travel very rapidly. A vertical and a horizontal rudder would be required, the latter elevated above the water, and both somewhat larger in area than the ordinary marine rudder.

Granted sufficient wing area and wing power, and it is obvious that such a vessel would rise in the water as it increased in speed, until it left the surface of the water entirely. There would be no need to rise more than a few inches (or a few yards at most in rough weather) above the surface of the ocean, and it would be easy to descend upon the surface of the water when it was required to do so, the paddles, even when not in motion, acting as parachutes.

(3.) The perfect feathering paddle. This, as I am aware, is the "crux" of the whole question. Each paddle should consist of four fans of very thin sheet steel or aluminium, forming the four equal segments of a circular disc. The shaft of each fan should be attached to the axle in a ball and socket joint, in which socket the shaft would turn half round at each revolution, so as to offer alternately its edge and its fan-shaped surface to the direction of revolution. Attached to the lower portion of each shaft, which would be stripped of the fan projection so far up, would be a guiding arm hinged to the shaft, its other end travelling in a circular path or groove parallel to the direction of motion of the paddle, the said path approaching close to the paddle shaft for half its course, and receding from it for the other half, so as to pull the shaft over in its socket. I am not sure that this is a completely satisfactory suggestion, but I believe it is perfectly within the power of applied mechanics to produce such a motion in a satisfactory way. The paddle fans would be slightly concave at their edges, so as to offer the concave surface to the air in the effective part of their revolution.

(4.) The wing area and energy must be commensurate with that of a typical flying bird. I have chosen the gannet, a well-known English sea bird, which, according to Dr. Pettigrew, in his "Dissertation on Animal Locomotion," page 134, extends a wing area of 5ft. 6in. to support its weight of 7 lbs., equivalent to a supporting area of sixty-six inches to every pound weight, with a velocity of 100 up and 100 down strokes per minute. I have found this calculation confirmed by another writer on "Animal Physiology," and I take it to be reliable. At this rate it would require a wing surface of roughly 1,026 square feet for every ton. It should be remembered, however, that the powers of flight of every bird are in excess of its normal requirements; it is able not merely to carry its own wight, but to carry a considerable additional weight, in its flight. The gannet, for instance, can dart into the water, pick up a fish of a pound or more in weight, and fly with it into the air again. And again, the calculation of one thousand odd square feet for every ton of weight is fallacious in another respect. It would only hold good if the paddles of the flying machine were no longer than the wings of the gannet, somewhat less than three feet. If the paddles were six feet or upwards in length their outer edge would revolve through the air with exactly double the speed, and probably more than double the energy of the three-foot wing, although the speed at the axis was the same. On a rough calculation, then, we may suppose that a wing area of one thousand feet would lift one ton if the paddles were the same length as the gannet's wing, two tons if they were twice as long, and three tons if they were three times as long, supposing always that the velocity of rotation at the axis was one hundred revolutions per minute. It is more than probable that steel and iron machinery driven by steam could greatly exceed the velocity of the bird's wing. If then we could attain a speed of two hundred revolutions per minute, we should again double the lifting and propelling power of our paddles.

The objection occurs to me that one paddle might follow so quickly after the other that the air would not have time to return after its displacement by the preceding paddle, that there would be therefore a certain amount of what in nautical parlance is termed "slip." It would perhaps tend to obviate this possibility if the paddles were made with only two fans, each forming the half segment of a circle.

To sum up. A paddle with a seven feet radius would give a total wing area, whether with four fans or two, of approximately 150 square feet. Three pairs of such paddles on the deck level would give a wing area of 900 square feet. On a frame elevated above the deck two pairs of paddles with a radius of ten feet would give a wing surface of 1,256½ feet, or both tiers of paddles together 2,156½ feet, which would suffice at a speed of one hundred revolutions per minute to lift and propel a weight of upwards of four tons, or of eight tons at twice that speed. A vessel lightly built as suggested of steel and aluminium, not necessarily exceeding thirty feet in length, with marine engine, paddles, and mechanism required, could probably be built to such a weight. The longer the paddles and the more extended in area, the greater would be the advantage.

The paddles at the deck level, which would have to do duty in the water as well as in the air, would have to be comparatively small in area, and revolving in a denser medium they would require the full force of the engines, but when full speed was attained, the movement of a lever could put the upper tier of paddles into connection with the gearing, and so into motion. This upper tier of paddles could be made as large as the weight required, and as the engines were competent to revolve.

The flying machine thus suggested would be competent to fly over the water's surface; but only to a very limited degree, and not without risk, over the land. The irregularities of the earth's surface, hills and valleys, trees, houses, factory chimneys, telegraph wires, and so on, would necessitate that the machine should travel at a much greater height above the land than above the sea, and any stoppage of the engines, or accident to the mechanism, might, and almost certainly would, mean irretrievable disaster.

Inland travelling, to some extent, might be conducted along the lines of the rivers and canals, but the principal scope of the flying machine would be to supersede the discomfort and delay of over-sea transit. The speed and comfort of our present railway travelling are almost unsurpassable. It is in competition with the Calais-Dover and other over-sea lines that the flying machine would prove its enormous superiority. Who would undergo the agonies of *mal de mer* and the long-drawn misery of a rough passage when they could be wafted across in a "flying machine"? "'Tis a consummation devoutly to be wished," and one which I venture to prophesy we shall all of us see before we are many years older.

# Some Early Flights.

BY DOUGLAS LEECHMAN, A.I.M.E., C.P.A.

MOST *habitués* of the Patent Office are familiar with the stumpy little books which contain the first series of abridgments of British patents. These are not illustrated—more's the pity—but what the volume on Aeronautics lacks in value in this way is partly made up for by a most interesting introductory article, including a chronological review, the substance of which is here reproduced. Evidently much attention was given to the subject of aeronautics about the year 1783:

400 B.C. Archytas constructed a wooden pigeon which could fly by mechanical means. To wit, it was thus suspended by balancing, and was animated by an occult and enclosed aura of spirit. If the pigeon fell it could not lift itself up any more.

1650 A.D. John Baptist Dante, about 1650, is said to have framed certain wings, by means of which he flew several times, but at last had the misfortune of breaking one of his thighs in an attempt of that sort.

1736. De Gusman made a wicker basket of about seven or eight feet in diameter, and covered with paper, which basket elevated itself as high as the tower of Lisbon, which is about 200 feet high.

1767. Dr. Joseph Black, of Edinburgh, stated in his lectures that it was an obvious consequence of Cavendish's discovery of the lightness of "inflammable air" (or hydrogen gas) that, if a sufficiently thin and light bladder were filled with inflammable air, the bladder and air in it would necessarily form a lighter mass than the same bulk of atmospheric air, and which would rise in it.

1782. Tiberius Cavallo, in the early part of 1782, after trying many experiments with paper envelopes, etc., caused "soap balls," or bubbles filled with inflammable air, to ascend to the ceiling of a room.

1782. Stephen Montgolfier, in November, 1782, at Avignon, made a fine silk bag in the shape of a parallelopipedon, the capacity of which was equal to about forty cubic feet. Burning paper applied to its aperture served to rarefy the air.

1783. Stephen and John Montgolfier, on June 5th, 1783, at Annonay, before the States of Vivarais, caused a fire balloon, or a balloon of rarefied air, to ascend to the height of about 6,000 feet.

1783. MM. Charles and Robert, on August 27th, 1783, caused a balloon filled with inflammable air to ascend from the Champ de Mars, Paris, to a height of 3,123 feet in the presence of many hundred thousand spectators. This balloon fell fifteen miles from Paris.

1783. M. Deschamps, a painter, at Paris, proposed to the Baron of Beaumanoir to try gold beater's skin for an air balloon. The Baron, on September 11th, 1783, successfully launched a balloon 19in. diameter, made according to this plan; it went out of sight.

1783. J. Montgolfier, on September 19th, 1783, launched a fire balloon from Versailles in the presence of Louis XVI. and the Royal Family. This machine carried a sheep, a cock, and a duck; they alighted in safety in the wood of Vaucresson.

1783. M. Pilatre de Rozier, on October 15th, 1783, ascended to about eighty-four feet from the ground in the gallery of a fire balloon. This ascent was limited by ropes that detained the balloon.

1783. M. Pilatre de Rozier and Marquis d'Arlandes, on November 21st, 1783, performed an aerial voyage in a free fire balloon from the garden of the Chateau de la Muette, near Paris. The aeronauts descended about 9,000 yards from the place of ascension.

1783. MM. Robert and Charles, on December 1st, 1783, ascended in an air balloon from the Tuileries. This balloon descended in safety at Nesle, again rose with M. Charles alone in it, and descended three miles from the place of its second ascent.

1783. M. le Normand employed a parachute to let himself down from the windows of a high house at Lyons. The practical application contemplated was escape from fire.

1784. M. Jean Pierre Blanchard, on March 2nd, 1784, ascended in an air balloon from Paris and descended near Sevres. He carried up with him wings, a gouvernail, and a sort of umbrella to break his fall in case of an accident.

1784. M. de Saussure, in a letter dated March 26th, 1784, mentions his having made some experiments on the atmospherical electricity, with an aerostatic machine, which was raised by means of the combustion of spirits of wine, and was fastened to a long string. In a cloudy day he obtained a positive electricity strong enough to afford sparks.

1784. Mons. Fleurant and Mad. Thible, on June 4th, 1784, ascended from Lyons in a fire balloon called " Le Gustave." The first observations of a scientific character were said to be made on this voyage.

1784. Dr. Joseph Black wrote to Dr. James Lind, stating that in that year his experiment of raising a bladder by means of inflammable air had been tried with success.

1785. Tiberius Cavallo notices that pit coal exposed to a red heat gives abundance of inflammable air. He remarks, further, " It appears, therefore, that pit coal is the substance which may be most advantageously used for the production of inflammable air in aerostation." In a footnote he states that " On the Continent various small balloons have been filled with the inflammable air of pit coal, and have floated exceedingly well."

1793. M. Blanchard endeavoured to demonstrate the efficiency of a parachute. He came to the ground quickly and broke his leg.

1794. Guyton de Morveau, on June 26th, 1794, at the battle of Fleurus, had the charge of a balloon for reconnoitring the Austrian position. This balloon is said to have done good service to the Fernch cause.

1797. Andre Jacques Garnerin, on October 21st, 1797, descended from a balloon by the aid of a parachute. The parachute was separated at a height of about 2,000 feet.

1804. MM. Gay Lussac and Biot ascended from Paris on August 23rd, 1804, to make scientific experiments. They reached a height of 13,000 feet, and did not find any difference between their results and those obtained on the earth.

1804. M. Gay Lussac, on September 15th, 1804, ascended to the height of 22,977 feet. He found the time of the vibration of a magnet to be less than on the earth. His respiration was affected. The temperature and humidity of the air decreased. He filled some glass bottles with air from the higher regions; was five hours and threequarters in the air, and noticed that the sky was of a deep blue.

1821. Mr. Charles Green made his first ascent on July 19th, 1821, the coronation day of His Majesty George IV. He is said to be the first that employed coal gas.

1836. Messrs. Charles Green, Holland, and Monck Mason, on November 7th, 1836, started in the Nassau balloon from Vauxhall Gardens, and accomplished a journey to Weilburg, in the Duchy of Nassau, in eighteen hours.

1837. Mr. Cocking, on July 24th, 1837, descended in a parachute from a balloon and was killed. The parachute was shaped like an inverted cone, and was made according to his own design.

1852. Mr. Welsh, of the Kew Observatory, made four ascents in the great Nassau balloon with Mr. Green. The greatest altitude that he reached was 22,930 feet. They observed that the temperature of the air decreased uniformly with the weight above the earth's surface until at a certain elevation varying on different days, the decrease is arrested, and for the space of 2,000 or 3,000 feet the temperature remains nearly constant, or even increases by a small amount, the regular diminution being afterwards resumed and generally maintained at a rate slightly less rapid than in the lower part of the atmosphere, and commencing from a higher temperature than would have existed, but for the interruption noticed.

1862. Mr. James Glaisher, on July 17th, 1862, ascended with Mr. Coxwell from Wolverhampton to a height of nearly five miles. The temperature of the air and the dew point were determined at various altitudes; electrometer readings, times of magnetic vibrations, ozone observations, and other data were obtained. This was the first of a series of balloon ascents undertaken at the request of a committee appointed by the British Association for the Advancement of Science to make meteorological and physical observations at different elevations above the earth's surface.

1865. Mr. James Glaisher, on October 2nd, 1865, in pursuance of his researches for the balloon committee of the British Association for the Advancement of Science, made his first night ascent. This night was remarkably clear, and the temperature, up to a certain elevation, increased with the increase of elevation.

As a sample of the abridgments themselves, we can hardly do better than give the first, which shows the inventors to have held wonderfully advanced ideas on their subject.

A.D. 1815, April 25th, No. 3,909. Pauly, Samuel John, and Egg, Durs. "Certain aerial conveyances and vessels to be steered by philosophical or chemical and mechanical means, and which means are also applicable to the propelling of vessels through the water, and carriages, or other conveyances by land."

The aerostat or balloon has a "form whose farthest extremities may be in a horizontal and longitudinal direction, or nearly so, such as the shape of a fish or bird. A frame round the lower part of the aerostat called the head frame holds the net, as well as an appendage capable of acting as a parachute, and the requisite suspensory fastenings of the car. To drive and direct the balloon, fins, feathers, fans, or wings are employed; they are made of silk fixed to a staff by whalebone ribs. Five feathers may form a ring, and for that purpose are fixed alongside into a head-piece, which is applied to a steel spring fastened to the head frame, playing backwards and forwards horizontally. Each separate fin, feather, fan, or wing has a threefold power, which we call attractive, aspiring, or sucking, repulsive, driving, or blowing, and collective or uniting." The tail or rudder is formed of the same materials as the said fins. A movable weight, consisting of a barrel containing water, is used as ballast for guiding and directing the balloon. The said fins may also be applied to a machine that is capable of raising and supporting itself in the air without the assistance of gas.

# Some Aeronautical Experiments.

## A Paper read by Mr. Wilbur Wright, Dayton, Ohio, before the Western Society of Engineers.

*(Continued from page 140.)*

On resuming our gliding, we found that the old conditions of the preceding year had returned, and after a few trials made a glide of 366 feet, and soon after one of 389 feet. The machine with its new curvature never failed to respond promptly to even small movements of the rudder. The operator could cause it to almost skim the ground, following the undulations of its surface, or he could cause it to sail out almost on a level with the starting point, and, passing high above the foot of the hill, gradually settle down to the ground. The wind on this day was blowing eleven to fourteen miles per hour. The next day, the conditions being favourable, the machine was again taken out for trial. This time the velocity of the wind was eighteen to twenty-two miles per hour. At first we felt some doubt as to the safety of attempting free flight in so strong a wind, with a machine of over 300 square feet, and a practice of less than five minutes spent in actual flight. But after several preliminary experiments we decided to try a glide. The control of the machine seemed so good that we then felt no apprehension in sailing boldly forth. And thereafter we made glide after glide, sometimes following the ground closely, and sometimes sailing high in the air. Mr. Chanute had his camera with him, and took pictures of some of these glides, several of which are among those shown.

We made glides on subsequent days, whenever the conditions were favourable. The highest wind thus experimented in was a little over twelve metres per second—nearly twenty-seven miles per hour.

It had been our intention when building the machine to do the larger part of the experimenting in the following manner: When the wind blew seventeen miles an hour, or more, we would attach a rope to the machine and let it rise as a kite with the operator upon it. When it should reach a proper height, the operator would cast off the rope and glide down to the ground just as from the top of a hill. In this way we would be saved the trouble of carrying the machine up hill after each glide, and could make at least ten glides in the time required for one in the other way. But when we came to try it we found that a wind of seventeen miles, as measured by Richard's anemometer, instead of sustaining the machine with its operator, a total weight of 240 lbs., at an angle of incidence of three degrees, in reality would not sustain the machine alone—100 lbs.—at this angle. Its lifting capacity seemed scarcely one-third of the calculated amount. In order to make sure that this was not due to the porosity of the cloth, we constructed two small experimental surfaces of equal size, one of which was air-proofed, and the other left in its natural state; but we could detect no difference in their lifting powers. For a time we were led to suspect that the lift of curved surfaces little exceeded that of planes of the same size, but further investigation and experiment led to the opinion that (1) the anemometer used by us over-recorded the true velocity of the wind by nearly fifteen per cent.; (2) that the well-known Smeaton co-efficient of $.005 V^2$ for the wind pressure at ninety degrees is probably too great by at least twenty per cent.; (3) that Lilienthal's estimate that the pressure on a curved surface having an angle of incidence of three degrees equals .545 of the pressure at ninety degrees is too large, being nearly fifty per cent. greater than very recent experiments of our own with a special pressure testing machine indicate; (4) that the superposition of the surfaces somewhat reduced the lift per square foot, as compared with a single surface of equal area.

In gliding experiments, however, the amount of lift is of less relative importance than the ratio of lift to drift, as this alone decides the angle of gliding descent. In a plane the pressure is always perpendicular to the surface, and the ratio of lift to drift is therefore the same as that of the cosine to the sine of the angle of incidence. But in curved surfaces a very remarkable situation is found. The pressure, instead of being uniformly normal to the chord of the arc, is usually inclined considerably in front of the perpendicular. The result is that the lift is greater and the drift less than if the pressure were normal. Lilienthal was the first to discover this exceedingly important fact, which is fully set forth in his book, "Bird Flight the Basis of the Flying Art," but owing to some errors in the methods he used in making measurements, question was raised by other investigators not only as to the accuracy of his figures, but even as to the existence of any tangential force at all. Our experiments confirm the existence of this force, though our measurements differ considerably from those of Lilienthal. While at Kitty Hawk we spent much time in measuring the horizontal pressure on our unloaded machine at various angles of incidence. We found that at thirteen degrees the horizontal pressure was about 23 lbs. This included not only the drift proper, or horizontal component of the pressure on the side of the surface, but also the head resistance of the framing as well. The weight of the machine at the time of this test was about 108 lbs. Now, if the pressure had been normal to the chord of the surface, the drift proper would have been to the lift (108 lbs.) as the sine of thirteen degrees is to the cosine of thirteen degrees, or $\frac{.22 \times 108}{.97} =$ 24+ lbs.; but this slightly exceeds the total pull of 23 lbs. on our scales. Therefore, it is evident that the average pressure on the surface, instead of being normal to the chord, was so far inclined toward the front that all the head resistance of framing and wires used in the construction was more than overcome. In a wind of fourteen miles per hour, resistance is by no means a negligible factor, so that tangential is evidently a force of considerable value. In a higher wind which sustained the machine at an angle of ten degrees, the pull on the scales was 18 lbs. With the pressure normal to the chord, the drift proper would have been $\frac{.17 \times 98^{*}}{.98} = 17$ lbs., so that although the higher wind velocity must have caused an increase in the head resistance, the tangential force still came within one pound of overcoming it. After our return from Kitty Hawk we began a series of experiments to accurately determine the amount and direction of the pressure produced on curved surfaces when acted upon by winds at the various angles from zero to ninety degrees. These experiments are not yet concluded, but in general they support Lilienthal in the claim that the curves give pressures more favourable in amount and direction than planes; but we find marked differences in the exact values, especially at angles below ten degrees.

---

* The travel of the centre of pressure made it necessary to put sand on the front rudder to bring the centres of gravity and pressure into coincidence, consequently the weight of the machine varied from 98 lbs. to 108 lbs. in the different tests.

*(To be continued.)*

# Short Flights.

M. Bradski has undertaken to reconstruct the airship which collapsed with M. Severo, giving special attention to remedying the defects which led to its destruction.

* * *

While preparing for a balloon ascent at Mold, a London aeronaut was rendered insensible by escaping gas. He did not recover consciousness until next morning.

* * *

Lecturing before the French Society on the adaptability of liquefied air to navigable balloons, M. Georges Claude gave it as his opinion that it can never be used for purposes of locomotion. M. Claude finds that 20 lbs. of liquefied air only achieve results that can be secured by 1 lb. of petroleum. It can be used, however, for inhalation at high altitudes, and for enabling specimens of the upper atmosphere to be secured for subsequent analysis.

* * *

With a view to testing a new method of steering balloons across water, the Rev. John M. Bacon is preparing to make the passage of the Irish Channel by air. Presuming that this will be a trial of considerable interest and value, but not unattended with risk if due precautions are not taken, the famous aeronaut will be glad if any owner of a yacht or other vessel who may be disposed to accord him escort will be at hand in case of immersion.

MM. Henri Mager and Chas. Cadet have completed the plans for an airship which they assert will travel at a speed of sixty miles per hour in calm weather. They will attempt the traverse of the Sahara with their ambitious craft.

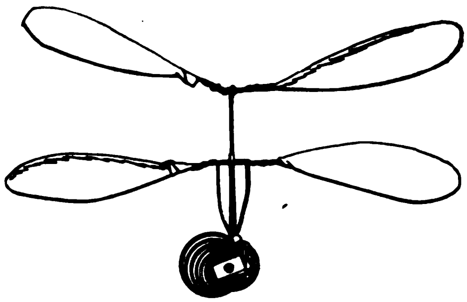
* * *

The Aeronautical Institute and Club, of which Mr. O. C. Field, 20, Adelaide Road, Brockley, S.E., is hon. secretary, is doing good service in the cause of aeronautics. Meetings are held at frequent intervals, and the papers and discussions are always interesting. Besides the merely academical interest shown in the movement, practical experiments are undertaken, and several instructional balloon ascents have already been made.

* * *

A Belgian is credited with a new flying machine, light and very simple in design. The motor is fitted with a vertical shaft, constructed in such a way as to support a horizontal shaft provided with a gearing of suitable toothed wheels, and working two large screws, which act vertically, and impart the force necessary. The vertical shaft supports also, a little below the main shaft, another small horizontal shaft, which it puts into movement in the same manner, and which, by means of two small screws, controls the horizontal movement of the apparatus.

## A Flying Model.



**Drawing (from a photograph) of a small flying model made from an egg beater fitted with paper wings, and kept in motion by means of a spiral spring, shown by Mr. R. Shapland, of 231, Lordship Road, Dulwich, S.E., to the members of the Aeronautical Institute and Club at a recent meeting.**

Mr. Shapland states the model proves that machines of fairly heavy construction can be made to fly, if sufficient power is applied (without excessive weight). In this case the frame can be said to be of cast iron, one large and two small cog wheels of the same material, solid iron wire covered with paper for fans, and a heavy steel clock spring, which exerts sufficient power to turn the fans in opposite directions, and lift itself from floor to ceiling of a room. The first of these he made in Adelaide, South Australia, about twenty-two years ago.

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on the Construction of Dirigible Balloons,
Aërostats, Aëroplanes, and Aëromotors.

BY

FREDERICK WALKER, C.E.,

*Fellow of the Society of Patent Agents, Associate Member of the Aëronautic Institute.*

*Author of "Practical Dynamo Building," "Tables and Memoranda for Electrical Engineers," "Electricity in the Engine Room," "Design and Equipment of Launches," etc.*

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(See page 210.)

# Flying.

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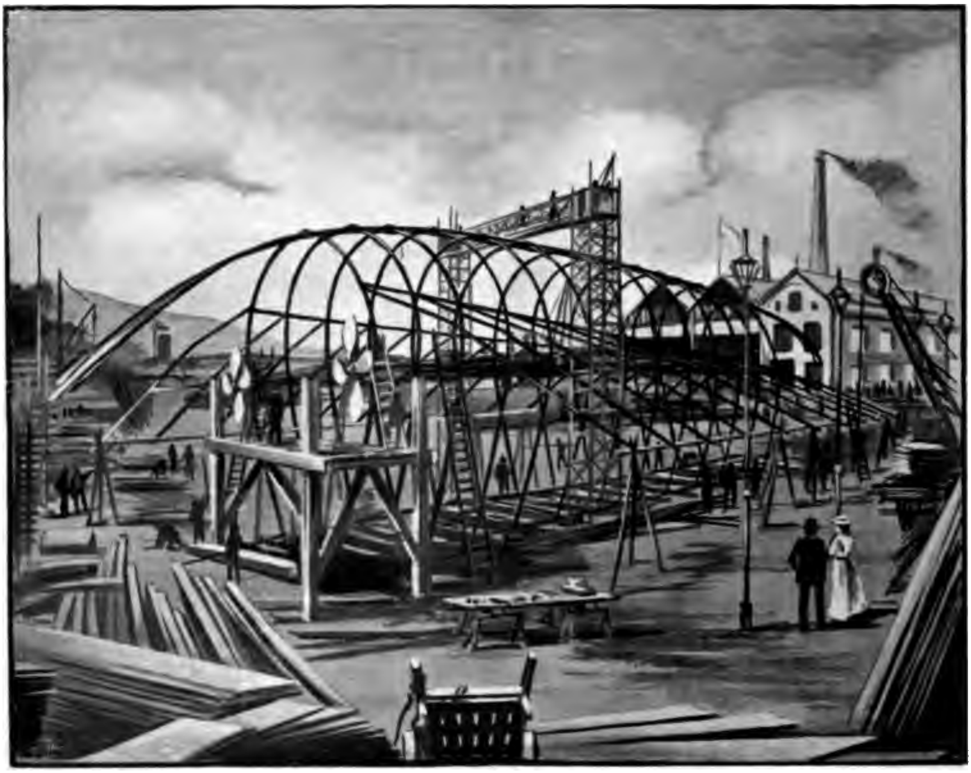
No. 5. QUARTERLY. JANUARY, 1903.

# The Conquest of the Air.

By Frederick Walker, C.E.

THE complete conquest of the air—the latest concession of the great forces to importunate mankind—is nearly an accomplished fact. Like all other scientific problems relating to social advantages appertaining to the human race, its advance has been by way of a step-by-step progression. From the balloon proper, which is subservient to the direction of every variable air current, to the dirigible aerostat, with intermediates in the shape of mechanical aviators, aeroplanes, and similar contrivances, we have at last arrived at a practical, if not a final, solution of the problem of aerial navigation. In the dirigible aerostat, in which the motive power is applied from a point upon a flexibly-suspended car, the conditions from a mechanical point of view are manifestly incomplete. The aerostat, exerting its buoyant power in a vertical direction, is an opposing resistance to horizontal motion. Thus the suspended car is intermittently propelled forwards, and the aerostat dragged onwards and downwards, until a moment of neutrality occurs, in which the buoyancy is again active and a certain amount of progress attained, which, being continued, results in a pitching and tossing movement like that of a ship in a head seaway. When a flying machine is designed upon the principle of a self-propelled aeroplane, the attendant difficulties in the way of success are, in the necessity for an initial impulse at a high rate of speed upon a railed track, not always accessible, an uncertain stability in flotation, and, lastly, the great unbalanced weight of the necessary mechanism. True aviators, with flapping wings, are also impracticable for large machines for purposes of utility. In every case in which man has adopted artificial locomotion he has never followed Nature as a teacher, nor copied her methods of applying force. Upon the land he substitutes a mechanically-driven wheel for the system of levers used in animal locomotion, and on and under the sea he does not accept the fin as a prototype, but uses the more effective screw propeller. It follows, therefore, that he does not look to the bird or bat for guidance in the matter of aerial propulsion, although he does not disdain to adopt a few minor " wrinkles " in the way of automatic balancing.

Hence the practical airship is a combination of the aerostat and aeroplane, with a peculiar adaptation of screw propellers. Look at the huge skeleton of an "air liner" in process of construction at the "yard." The back and ribs resemble the osseous structure of a gigantic antediluvian saurian, the tubular steel frames tapering from root to extremity to afford the maximum of strength with the minimum of weight. The car frame is integral with the major rib structure, and is consequently rigid; and upon the "Spezia" plan the vast aeroplanes enclose twin propellers of immense size. This method of enclosure, in combination with a system of splitting the active surface into aerocurves, affords the highest degree of efficiency in utilising the volume of air displaced. A semi-covering or *chemisette* of thick waterproof fabric is interposed between the frame and the more delicate envelope of the aerostat. This latter is cellular, and is deflated into a hydrogen reservoir under pressure by a powerful pump, and inflated when necessary by a reverse process. This action and that of maintaining the equilibrium is automatically performed by a delicate, though reliable, mechanism, the description of which is beyond the space of this article.



BUILDING THE FRAME OF THE "SPEZIA."

The railway, the steamship, and the automobile car were in their time decried and termed impossible by the pessimists, then smilingly admitted to be amusing eccentricities, and behold! like a magical transformation, in a short time all these wonders become indispensable alike to optimist and to pessimist. Imagine a huge terminus, say on Wimbledon Common, where the winged giants are resting, each ready to start to time, carrying its complement of passengers to the confines of the kingdom—nay, the Empire itself. What a splendid bird's eye view crossing the mighty ocean, watching the resistless waves and the pitching rolling liner with her creamy wake and the thunderous seas recoiling from her bows, from an elevation above the turmoil of the "rolling forties"! On its air-borne course the immense car, replete with every comfort, literally wings its way to distant shores with as little risk to life and property as obtains in the case of the great liner far beneath it. Even if the mechanism should fail, the surface of the aeroplanes allows of a very gradual descent, and safety appliances of every kind will be to hand in the air liner of the immediate future. One has but to consider the dimensions of our modern Atlantic liners, and remember the fact that 146 cubic feet of hydrogen in an aerostat will support 10 lbs. weight, and 200 square feet of aeroplane surface will support the same weight when opposed to a volume of air moving at the rate of 1,760 feet per minute, to at once admit that the aerial transport of 500 passengers is quite reasonable. The latest development of the hydrocarbon internal combustion engine allows of the highest efficiency without the disadvantages of water-cooling, the external radiation at no time being dangerous. M. Santos-Dumont, Count von Zeppelin, and Dr. Barton have each conferred a benefit upon mankind by the respective steps towards final success due to their recent experiments; but still a distinct advance is shown in these illustrations.

THE GRAND TERMINUS.

There is something fascinating in watching the flight of a soaring bird, and, probably, apart from the sporting instinct, this quality extends to pigeon-flying. So in the future—and not a very distant period—the automobile car will have a formidable rival in the air yacht. From the view point of a captive balloon, no more graceful and beautiful sight may be imagined than a fleet of air yachts in the mazy evolutions of an aerial regatta. To enjoy the panoramic view in the exhilarating atmosphere of the higher altitude, and at the same time to participate in the sport attending a regatta, will popularise the new navigation beyond the limits of more terrestrial amusements.

AN AERIAL REGATTA.

The airship as a war auxiliary has already been favourably considered by the British War Office, since Dr. Barton has been commissioned to build a special ship for experimental purposes. A searchlight of suitable calibre fitted upon an airship and directing the light focus vertically downwards, but covering a large area at the base of the cone of light, will reveal the approach of an enemy's fleet while itself out of range, to good effect and to better advantage than the fan-shaped rays of a projector closer to the water. In daylight the approach of a submarine vessel may be discerned from an airship at a considerable altitude, and its direction and progress signalled by wireless telegraphy. The airship is vetoed by the International Congress as an aggressive instrument from humane motives. One is inclined to question the humanity that admits of the submarine torpedo vessel which invisibly, but fatally, attacks from below, as against the visible aerial torpedo with its individual

PASSING AN OCEAN LINER AT SEA.

AN AIRSHIP WITH SEARCHLIGHT IN WARFARE.

invulnerability, but no less deadly action.

We have the comforting assurance that the multiplicity of deadly inventions acts as a deterrent, and tends to render warfare well nigh impossible in the future.

No doubt at first aerial voyaging will be expensive—a mode of enjoyment to be monopolised by the wealthy and leisured classes of all countries—but it must be remembered that the same exclusiveness has attended the first stages of progress in every known instance of artificial locomotion. And also it cannot be denied that the advancement of aerial navigation has hitherto been slow, simply by reason of the definite common knowledge of the force of gravity and the prevailing ignorance of the inherent sustaining power of the air and its attributes. In other words, there has been, and to a great degree now exists, a want of confidence: but now that aerial navigation has been practically demonstrated, its progress will be by leaps and bounds. It does not require a vivid imagination or an especial spirit of prophecy to foresee in the very near future airships great and small traversing the upper air without exciting the wonder of the man in the street, or evoking a comment of greater emphasis than those he now wastes upon that painful but strangely inevitable topic—the weather.

# The Aeronautical Institute and Club.

THE first annual general meeting of the Aeronautical Institute and Club was held at St. Bride's Institute, Fleet Street, E.C., on Friday, December 12th, 1902, the president, Dr. F. Alex. Barton, in the chair.

The President, in opening the meeting, remarked that this was the first annual meeting held by the Institute, and he thought that members had every reason to congratulate themselves on the success of the past twelve months. The monthly meetings had been carried out with regularity, and they had had some interesting papers submitted for discussion. The prospect for the coming year, he thought, was a fair one. Papers had been promised for the coming meetings, and with regard to the exhibition which it was proposed to hold about the middle of the year, this was now practically assured, as the promised support from members had been most encouraging. The Institute had been formed for practical work, and he hoped that the exhibition would show that it was in every sense an institute of practical men.

The executive for 1903 was then elected as follows: *President*, Dr. F. Alex. Barton, Beckenham. *Vice-presidents*, Messrs. P. L. Senecal (founder), London; and M. Middleton, Brighton. *Committee*, Messrs. P. Y. Alexander, Bath; C. H. M. A. Alderson, Farnborough; and W. Dick, H. E. Holtorp, Aug. E. Gaudron, R. McNair, and G. Nicholl, London. *Honorary secretary* (general), O. C. Field, 20, Adelaide Road, Brockley, S.E. *Honorary secretary* (editorial), E. C. Dwyer, 6, Madeira Road, Streatham, S.W.

Mr. O. C. Field, the honorary secretary, read a carefully-prepared report of the year's work. In this he acknowledged the assistance which had been rendered to the institution by *Flying*.

# Motor Aviation of To-day and of Recent Years.

## By SIDNEY H. HOLLANDS.

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(Continued.)

### ASPIRATION.

The above suggestive sub-title, appropriate as it is to the pursuit of aeronautical science, is now used in its restricted and technical sense.

" Aspiration " is one of the curiosities of flight, and, indeed, is regarded by many of the uninitiated as quite paradoxical. The average mathematician is particularly sceptical about it, probably because he has hitherto failed to analyse it or to produce formulæ in accord with the observed conditions.

The aerial phenomenon " aspiration " has been well and simply defined by Mr. Octave Chanute, the well-known American authority, as " the act of flying in the face of the wind without using other power than that furnished by the wind itself."

It may be premised that " soaring " (in the technical sense) and " aspiration " are practically synonymous terms.

Atlhough the passive transit of certain large birds must have been observed and marvelled at probably from the commencement of the human era, it has remained for observers of comparatively quite recent times to investigate and, finally, to grasp intelligently the phenomenon on which that condition of flight is based.

Mr. Lancaster, of Chicago (a keen observer), has dealt largely and lucidly with this branch of flight, having made a special and a close study of it. He says:

" I profess to be now in possession of the secret (of aspiration), not possibly, nor probably, but, as a matter of fact, completely in possession of it

" This secret is not only experimentally proven, but it is self-evident. If there were not a soaring bird in existence nor an experiment ever made, it would be equally evident. I had piled experiment on hypothesis to the point of physical and mental exhaustion, when an accident revealed the entire matter in a moment, and I found myself in the ludicrous position of one who was diligently at work proving an axiom. My experiments were entirely worthless, and I cannot imagine an experiment of any kind whatever which would illustrate or prove the principles involved. Experiments would be valuable in working out details, but not in other respects.

" And now I must make a confession. I have written very positively thus far, but my convictions are based on certain notions entertained in regard to the mechanical laws which govern things, at least so far as this earth is concerned. If these laws are *not true* I take back all I have said. Chaos has come again. My knowledge of mechanical principles is wholly derived from English sources.

" The English text-books and mechanical journals have given me what I know about the mechanics of the universe, and if those writers who are, so far as I know, accepted everywhere, are correct, there is simply no doubt about 'soaring.' Five times five is not possibly, nor probably, twenty-five; *it is* twenty-five, if the multiplication table be right. If, then, gravity be a force distinct from the body exhibiting it, if its direction of action be towards the centre of the earth, if forces can be changed into other forces without passing into nonentity, if it be impossible for a force to do more work than its total capacity, if a body moves on the line of the resultant of all the forces acting on it, if elastic fluids under the action of mechanical forces react in all directions, then there is no doubt about the method of soaring.

"The English authorities from Newton to Professor Lodge are on trial before the facts, and no theory or hypothesis of mine. The bird is a mere accident of the case. An inert plane of proper shape, weight, and position would inevitably be impelled by the force of gravity as the bird is through the air.

"Again, it is obvious to my mind that, should any others devote their wealth and time for half a score of years to observations of the soaring birds, they could come to no other conclusion but the one given herewith, and it seems a wretched waste of effort to halt longer over the facts of soaring.

"Why not apply the mechanical axioms of the authorities to the operation of flying machines in such a way as to accomplish soaring flight? It seems like the part of wisdom to do so.

"A very brief statement of the matter will give the facts of the case. The first obvious fact is that a body heavier than the atmosphere, if it be inert and placed in free air entirely unsupported by anything but air, moves towards the centre of the earth under the action of gravity. If, then, it be asked why the bird does not get nearer the earth in its level or upward flight, the answer is because of another motion which elevates it as fast as it falls.

"There is no possible way to determine the *cause* of motion in a straight line by an examination of the moving body. It may be under the dominion of one force acting in one direction, or of any number of forces in any number of directions, when its course will be the resultant of them all. See all the authorities.

"A boy walks across the platform of a car in motion. He is going across the car, he is going along the road, and his track in space is the diagonal resultant of these two motions. Just so with the bird; it is falling flatwise in obedience to gravity. It is at the same time slanting upwards, edgewise on the plane of its wings. These two movements give the level one of flight. It is very singular that this precise complexity of movement can be seen on a large projectile after it leaves the muzzle of the gun, on a vessel sailing in a current, and in a multitude of similar cases, but cannot be seen in a soaring bird. How fast does the bird fall? Whatever its speed per second may be, its velocity is in all cases uniform. Its gravitating force accelerates it to the point where it is doing an amount of work on the air equal to the total capacity of the force at which point its velocity is uniform.

"That is what all the authorities say. Suppose this velocity to be six feet per second, that the wings are one foot wide, inclined one in six, or 2in. per foot, and that it is driven laterally on this upward slant at the rate of thirty-six feet per second, its path would then be level.

"So much for the motion. Now for the force. Suppose the bird to weigh 12 lbs., we would have a body falling at the uniform rate of six feet per second, and at the same time elevated through this distance. In the lateral motion there is skin friction, or air-resistance, on the sides of the wings, which is small, and, though eluding my attempts to measure it, is doubtless appreciable, and must be overcome. Now, the total force required to set up lateral motion must come from that developed in the air in the fall, and we are confronted by the law of falling bodies that no more work can be done by a body in falling a given distance than is required to elevate it the same perpendicular height. That is good law. All the authorities are agreed upon it.

"Here is the vital spot of 'soaring' (or 'aspiration').

"If *all* the air-developed force could be utilised in the rear expansion to force the bird forwards on the upward slant, it could only serve to accomplish the elevation, leaving the air-resistance to be still supplied. Now, the fact is that of the entire 12 lbs. of force developed in the air by the uniform fall, and which passes the rear edge of the wings each second, less than one-fourth is demanded for the lateral motion, and the balance of 9 lbs. goes to waste. As a matter of fact, the work of the fall gives a superabounding amount of energy for the purpose of flight.

"Notice that the law of falling bodies takes it for granted that the condition of both fall and elevation shall be the same. If the fall is in a vacuum and the rise in air, or water, or mercury, the conditions are not complied with. Much more would the conditions be disturbed if in the rise the weight was changed. This latter is precisely what takes place. In the deviation of the lateral motion the bird simply has no weight whatever, and being totally devoid of weight, the only force required in the lateral movement is enough to overcome skin friction or air resistance. Where is the weight if not in the bird? It is in the 12 lbs. per second of air-pressure, of course; where else could it be? It is there, if the authorities are right. If it is not there, but still in the bird, we have simply 12 lbs. of gravitating force created out of nothing, and the authorities say this is inadmissible. At six feet per second fall the total force is changed into air-pressure. The bird is in perfect equilibrium with the reacting air. It is exactly balanced by that air, and in this balanced state it passes over the thirty-six feet of horizontal distance. What I mean by saying that it has no weight is that, if scales were applied to it, it would not weigh anything. It resembles a 12 lb. weight balanced by another 12 lb. weight on an equal-armed scale.

"The whole matter is axiomatic. A certain amount of gravitating force cannot be *all* expended in doing work and have some left over to do more work with, viz., resist a force that elevates it. In the direct fall it is body plus weight. In the elevation it is simply body.

"As the air pressures pass the rear of the bird's wings they expand against the feather tips, which are curved upward, and drive the creature horizontally. Now, I have a bewildering mass of experimental evidence to support all this, or, as I would put it, which is supported by their axiomatic principles. The solution of the whole matter was in a completely unexpected direction, which left all experiments high and dry, stranded on barren flats."

The belief is held by some that "aspiration" is caused by natural upward air-currents. That, however, would not be "aspiration" in the true sense. There are some instances, at least, in which we may be practically certain it is not due to that cause, notably, the case of the wandering albatross when poised far aloft for hours on motionless wings. This bird, too, displays the phenomenon in a superlative degree, being the most striking and admirable instance of natural "aspiration." It is a marvel, and its aerial feats a revelation.

Again, the successful performance of the many and varied forms of "aspirating kites" and aerocurves in winds (and artificial air currents), *of known horizontal direction*, combats, and, indeed, may be said to refute, the upward current hypothesis. (See figs. 1 to 4.)

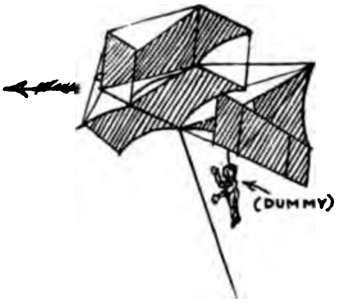

Fig. 1. Lamson, 1896.

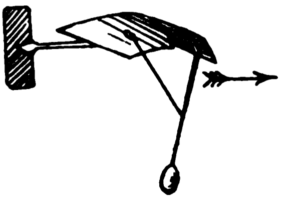

Fig. 2. Hargrave, 1898.

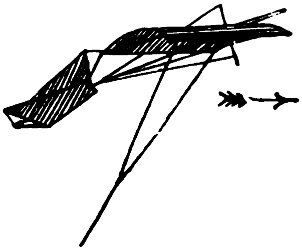

Fig. 3. Herring, 1896.

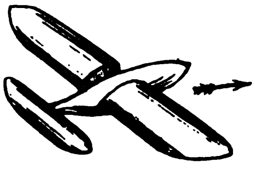

Fig. 4. Steiger, 1891.

As long ago as the year 1800, Dr. Thomas Young, the eminent physicist, demonstrated that a surface shaped and suspended horizontally by a thread (see fig. 5) would advance against a horizontal blast or air-current impinging upon the forward convexity of its upper surface.

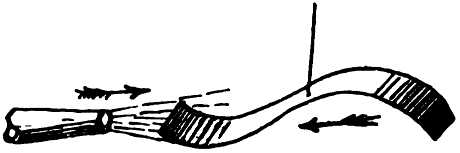

Fig. 5.

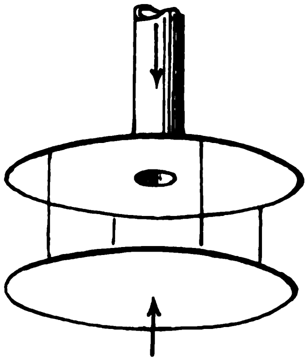

Fig. 6.

A very curious—even startling—demonstration of aspirating phenomena can be made by almost anyone, and with very simple apparatus. This experiment, which to all outward appearance is a complete paradox, is performed with the little piece of apparatus shown in fig. 6. It will be seen to consist of two horizontal parallel discs, the upper one having a central tube flush with its under surface, the lower one being a plain blank disc of equal diameter, and suspended from the upper one by three or more fine threads at a distance of about one-fourth of its diameter below it. Holding the apparatus with the tube vertical, and blowing vigorously down it, the upper disc will appear to have suddenly become highly magnetic, for the suspended disc will thereupon jump up *against the blast* and "hug" the upper disc closely—and the more so the stronger the blast is—and fall off when the blast ceases. If thin light discs of card or of sheet metal are used, the lower disc, while "hugging" the upper, will vibrate rapidly, producing a musical note.

Mr. Lawrence Hargrave, than whom there is not a more untiring and successful exponent of artificial "aspiration," has contributed a valuable paper to the literature of this branch of flight.

This paper, read before the Royal Society of New South Wales in September, 1897, is called "The Possibility of Soaring in Horizontal Wind." In it he says:

"The point of doubt has been how to account for the phenomenon of soaring in a horizontal wind. There is no difficulty in soaring if we assume an upward trend in the wind, such as a cliff, building, or sloping hill will produce. But when we see birds soaring in light wind and storm, something beyond our knowledge is recognised as being at work.

"Mr. Chanute shows the profile of a number of soaring and non-soaring birds' wings, and points out the downward projecting lobe at the front edge of the former, and also that there is a sharp curve just abaft the lobe on the underside (figs. 7 and 8).

"A few experiments have been made at Stanwell Park (Mr. Hargrave's former home) to show how this affects the effective direction of the wind when soaring, with the result, as I previously surmised, that it was found to create a vortex, and that the direction of the air current beneath the wing was that indicated by the arrows (figs. 7 and 8).

"This is all very well as far as it goes, but something is wanted that will eliminate errors of direction of the wind and some of the uncertainty as to the angles, and also to compare the curve with the plane surface. So I fixed a horizontal wire on a stand, and pointed it towards the blast. A sleeve was on the wire revolving freely. On opposite sides of the sleeve I attached a bulb-ended curved piece of aluminium and a piece approximately flat, with set-screws to fix them at any angle with the direction of blast. There was a lead-weight for balancing in the plane of rotation. There was nothing to stop the sleeve from slipping along the wire, which it did not do.

"You will observe that with this apparatus, if my personal equation gave any advantage to the curve, it would be eliminated when the sleeve revolved 180°, and that both surfaces received a blast of equal intensity; and that placing the two surfaces on opposite sides of one axis is equivalent to weighing their respective lifting powers in a pair of scales.

"The plane and chord of the curve were first set at a slight positive angle (fig. 9).

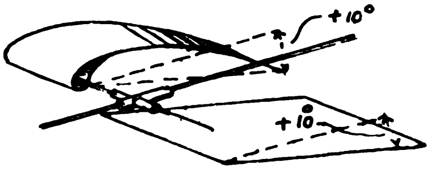

Fig. 9.

In this case the curve easily rotated the sleeve against the lift of the plane.

"There might possibly be no vortex under the curve, and the stronger rotating

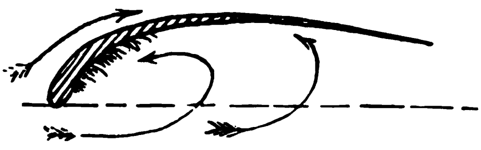

Fig. 7. Profile of soaring bird's wing.

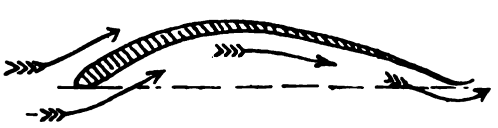

Fig 8. Profile of non-soaring bird's wing.

force might be due to the greater angle of slope of the after-part of the curve.

"The plane and the chord of the curve were next set parallel to the line of blast (fig. 10). In this case, the lifting force opposed by the plane to the curve was nothing, although its resistance was that due to its area and the velocity of the blast; and the lift of the vortex under the curve easily overcame this.

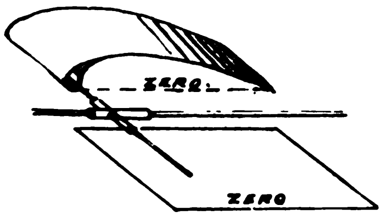

Fig. 10.

"In fig. 11 the plane was left parallel to the blast and the curve sloped at a negative angle. This angle was increased to at least 10°, and the lift of the curve still rotated the sleeve against the resistance of the plane.

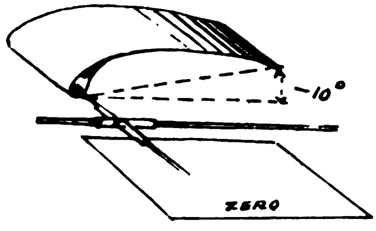

Fig. 11.

"In fig. 12 the plane was put at a positive angle of 6°—that is, 16° between the plane and the curve. The plane was now able to rotate the curve against the vortex.

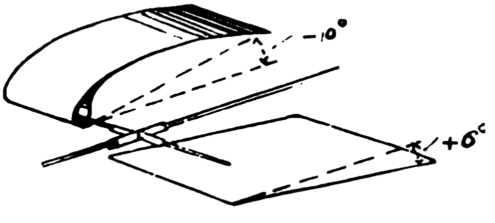

Fig. 12.

Figs. 13, 14, 15, and 16 show the stream lines of air when it meets a curve set at various angles."

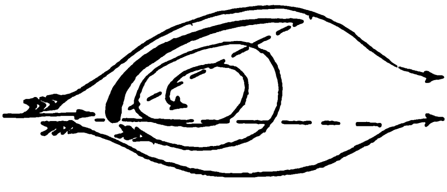

Fig. 13.

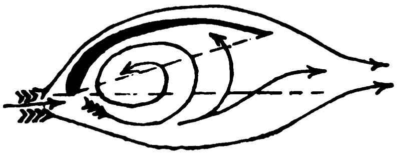

Fig. 14.

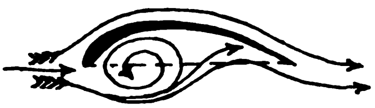

Fig. 15.

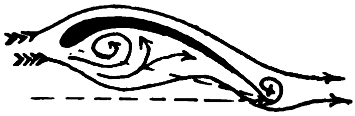

Fig. 16.

Mr. Hargrave then goes on to recapitulate his conclusions as follow:

"1. That the profile of a soaring bird's wing and pieces of metal of a somewhat similar curve generate vortices on the concave surfaces when the chord of the curves makes a negative angle with the direction of the wind.

"2. All the concave surfaces are in contact with air moving *towards* the mean direction of the wind."

*(To be continued.)*

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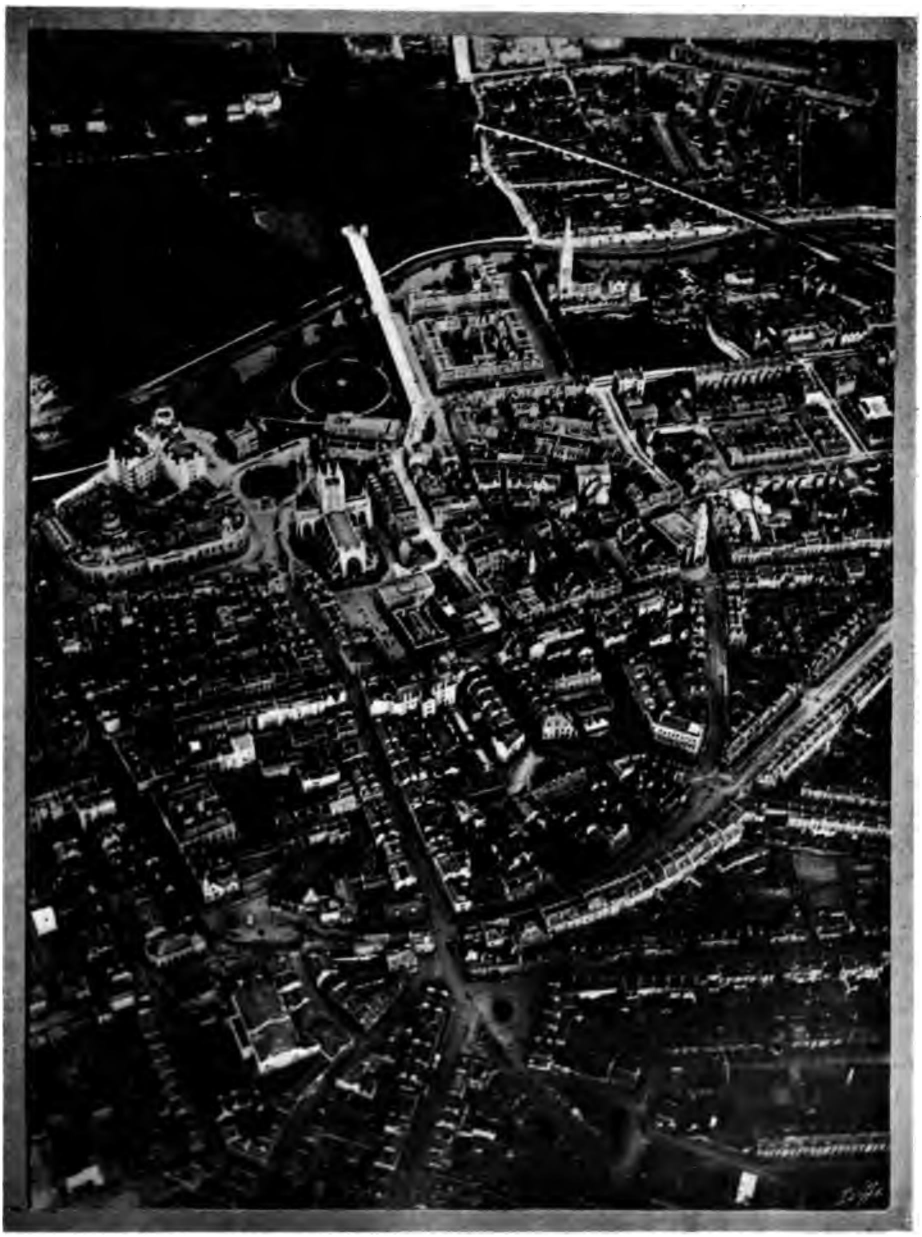
It is stated that the Brothers Spencer purpose constructing a powerful airship, in which an attempt will be made to travel from Hyde Park to Paris. The journey is expected to occupy five hours.

## A FINE SPECIMEN OF BALLOON PHOTOGRAPHY.



View of Bath City from a balloon, one of a series taken by Mr. Auguste E. Gaudron (Messrs. Gaudron & Spencer), on the occasion of the Garnerin Centenary Celebration held there by Mr. Patrick T. Alexander, in September last. The Abbey, Church, and the principal streets and public buildings are clearly distinguishable.

# The Late Percy S. Pilcher.

(*See Frontispiece.*)

PERCY SINCLAIR PILCHER, an ardent young aviationist, whose promising career was lamentably cut short at the early age of thirty-three, was a plucky emulator and an enthusiastic disciple of the late Dr. Otto Lilienthal.

Entering the Royal Navy early in life, he retired from it after seven years' service and took up mechanical engineering ashore. Passing the regular course through the shops in Glasgow, he for some time served as draughtsman with a marine engineering firm of that city, and then for two years with the Maxim-Nordenfeldt Co., at Erith, Kent. Latterly he became a partner in the engineering firm of Wilson and Pilcher.

Mr. Pilcher began experimenting in soaring flight at about the end of 1894. Adopting the general lines of the Lilienthal apparatus, he made a bold departure from the methods employed by the latter experimenter, by having his soaring machine towed on level ground by a pair of horses, through the medium of sheave-blocks and fall tackle and a strong line attached to the front of the machine.

Visiting Dr. Lilienthal in Berlin early in 1895, he then made his first glide--down the hillside—on one of his host's machines.

Mr. Pilcher became a member of the British Aeronautical Society in 1897 (was elected a member of Council in November of that year), and read an able and interesting paper on "Flying Machines" before that society in March, 1897.

It was during a visit to Lord Braye at Stanford Park, near Market Harborough, that poor Pilcher met with his lamented death.

Rather than disappoint a number of sympathetic friends and visitors—among those present being Miss Pilcher (his sister), Major Baden-Powell, the Hon. A. Verney Cave, and Mr. Henniker-Heaton, M.P. -Mr. Pilcher ill-advisedly decided to make his intended soaring experiments under sadly adverse conditions, *i.e.*, on a very gusty, showery day, which weather characterised Saturday, September 30th, 1899. The wet was apparently the primary cause of the fatal accident that ensued.

The first and second trials were effected successfully, Mr. Pilcher and machine soaring gracefully to a height of about 30ft. On the third attempt, when about the same height had been reached, a sudden and ominous snap was heard, the tail of the machine was seen to collapse, and the apparatus dived forward, making a complete somersault, and reaching the ground a wreck. The wet had shrunk the fabric, causing a stretcher-boom to snap.

Poor Pilcher, without regaining consciousness, only survived the fall until the following Monday morning, October 2nd. Like his admirable exemplar, Lilienthal, Pilcher was one who had made valuable additions to our knowledge of practical soaring flight, and as he was also a clever, courageous, and energetic young man could very ill be spared.

# New Airships in Paris.

SINCE his recent return to Paris, M. Santos-Dumont has found himself once more in an atmosphere peculiarly favourable to his studies in aerial navigation, and what is equally satisfactory is the manner of his homecoming and the way in which all the little unpleasantness which accompanied his previous departure has been forgotten in a general reconciliation with the members of the Paris Aero Club. The club itself took the first step by inviting M. Santos-Dumont to a banquet, at which he was to be presented with a gold medal, at the same time that another was to be awarded to M. De la Vaulx. The speeches of the Marquis De Dion and of the other members on the occasion of the presentation were no less cordial than the reply of the distinguished aeronaut, who expressed himself delighted at finding himself once more in the presence of the club; and finally it was proposed, and agreed to unanimously, that M. Santos-Dumont should be invited to withdraw his former resignation and be received back into the club without any other form or ceremony.

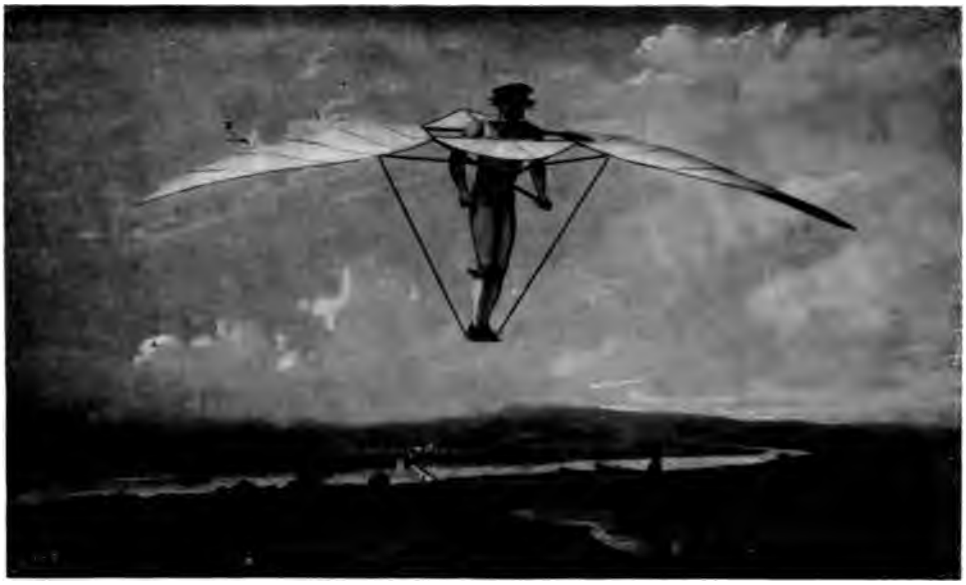
In the task he has now set himself, the Brazilian aeronaut thinks that he has done enough of purely experimental work, so far as concerns the navigability of balloons, and he is trying to turn his experience to practical account in the way of constructing an airship with large carrying capacity. Of course, this does not imply that the experimental work is yet at an end, for M. Santos-Dumont believes that he has only got over one stage towards the creation of a practical machine, and the airship he is now constructing differs in many respects from the navigable balloons he has used in the past. The preliminary trials in the way of stability and propelling power were carried out in his chambers in the Champs Elysées, where he had a small aerostat ballasted with a pair of boots. Having satisfied himself that his principle was right, he transferred operations to Vaugirard, where the new airship is being constructed in the shed formerly occupied by the unfortunate Severo and Baron de Bradsky.

M. Santos-Dumont is by no means disposed to take the public into his confidence regarding his new navigable balloon. He does not pretend that there are any secrets in its construction; but he has learned that the controversy carried on by other people, who know little or nothing about the subject, has an unpleasant knack of falling on his own head. For the sake of peace, he is working quietly at Vaugirard, and will not come out of his retreat until the airship is completed. In its external appearance the new balloon will be entirely different from the half-dozen other balloons that M. Santos-Dumont has constructed. It will be less elongated, and, instead of being shaped like a cigar, will take the form of an egg. It is also understood that it will have a much bigger keel, and the aeronaut intends to make long journeys with a number of passengers—twelve is the number suggested—who will naturally pay for the privilege; but for the moment these, of course, are merely projects, and everything turns upon the behaviour of the new machine.

At one moment there seemed a possibility of a very interesting competition between the Santos-Dumont airship and the navigable balloon which has been constructed for MM. Paul and Pierre Lebaudy by M. Surcouf. The maker of the Lebaudy balloon was reported to have made comparisons between the two systems that were not altogether favourable to the invention of M. Santos-Dumont, whereat the latter offered to match his airship against the Lebaudy for 100,000 francs. He even staked a quarter of this amount as an earnest of his challenge. MM. Lebaudy declined to take it up on the ground that they were pursuing a purely scientific work, and intended to continue their experiments in secret until they were satisfied as to the practical character of their balloon.

The Lebaudy airship was constructed in the yard of M. Surcouf at Billancourt, and transported to Moisson, a secluded village several miles to the west of Mantes, where the shed stands in enclosed grounds wholly safe from the enquiring eyes of journalists and the cameras of restless photographers, who have besieged the place in the hope of learning something about the balloon when it deigned to show itself above the horizon bounded by the tops of hoardings. What the spectators did see when the trials took place during November was a curiously-shaped aerostat, pointed at the ends, and curving down to the biggest diameter about one-third distance from the front end. The short keel, which will carry three persons, is suspended from a frame around the narrow bottom of the balloon. The capacity of the balloon is 2,500 cubic metres. Its length is 59 metres, and largest diameter 10 metres. It is made of thin sheets of rubber between two layers of cotton fabric—a system which has long been employed by the military balloon engineers in Germany and Austria. In this way, the envelope is absolutely impermeable to hydrogen gas. It is propelled by a 40 h.p. Daimler motor driving propellers three metres in diameter at 900 revolutions a minute. The airship only ascended two or three times in fine weather, first held captive and then free, and the trials appear to have been entirely satisfactory so far as could be judged from its evolutions during the short time it remained in the air. The Lebaudy airship was then packed up for the winter, and probably it will not make another appearance until the weather becomes more propitious in the coming spring.

The year 1903 will, indeed, see quite a number of new motor balloons. The Ville de Paris of MM. Deutsch and Tatin, of which the huge keel was exhibited at the Paris Automobile Show of 1901, will be completed, and the Marquis De Dion has also got one on the stocks, as well as M. De Mary and M. Louis Pillet, to say nothing of others which have little chance of being terminated unless the inventors can procure the necessary funds. Another interesting machine is the balloon which is being constructed for the French Government by Colonel and Commandant Renard at the military balloon station at Chalais-Meudon. It is being made of the same material as the Lebaudy—that is to say, with leaves of caoutchouc between cotton fabric—and its length will be four times the largest diameter. MM. Renard have not been tempted by the remarkable developments of petrol motors to employ this system of motive power, as they urge that the consumption of petrol is constantly affecting the stability of the balloon, and, moreover, they hold that such an inflammable liquid offers too many dangers to be employed safely in proximity to a gas-filled envelope. The keel, therefore, will carry a battery of accumulators like the Français, which performed so successfully in 1884-5; but with the new machine it is expected that the speed will be doubled, thus giving it about thirteen metres a second. It is found that this speed is absolutely necessary for the satisfactory management of a motor balloon. The year 1903, therefore, is likely to be full of interest for aerial navigation, though it is hoped that it will be devoid of the disastrous incidents and fatalities which, unfortunately, marked the past twelve months.



AEROSTAT, WORKED BY MANUAL POWER.
Invented by W. Miller, M.R.C.S., 1843.

We learn, although no reliable news has transpired as to Professor Langley's doings in the aeronautical field during the past year or so, that he has by no means been idle. It may now be credibly stated, however, that Professor Langley has for a considerable time past been conducting large scale experiments, and developing a full-sized practicable "aerodrome," by arrangement with, and with funds supplied for that purpose by, the U.S. Government. Moreover, Professor Langley recently said, "You may hear some interesting news in a short time."

The military wireless telegraphy operator in the United States carries the apparatus strapped to his back, while a small balloon serves for the necessary aerial paraphernalia, with a kite as an alternative.

* * *

In 1678, a French locksmith succeeded in providing himself with wings, and in "jumping off from a chair, then from a table, then from a window sill, and next from a second storey, and at length from the attic, on which occasion he sailed over the roof of an adjoining cottage." The locksmith was decidedly cautious.

# The Bicycle as an Accessory to True Flight.

BY SIDNEY H. HOLLANDS AND G. LACY HILLIER.

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## PART III.—GENERAL DESIGN AND CONTROL.

A CURIOUS fact, and one not very widely known, about inclined aerial sustaining surfaces—aeroplanes as well as aerocurves—is that the centre of pressure approaches the leading edge with the decrease of angle of inclination. Thus when the *chord* of the aerocurves subtends an angle of 15° with the plane of motion, the centre of pressure locates itself at one-third of the width of the aerocurve from the leading edge, and it continues to approach the leading edge without any further reduction of the angle of incidence *up to a certain point of acuteness*. When that point is passed, an unexpected and "a strange thing happens" (as the sensational novelists say), for the centre of pressure no longer advances, but recedes rapidly, so that at very acute angles of incidence the centre of pressure is back at approximately the centre of the width.

This latter phenomenon, *i.e.*, the *retrograde* movement of centre of pressure, does not occur with aeroplanes, but is peculiar to aerocurves. It is believed to be due to a portion of the air current being shunted *above* the aerocurve, and thus striking its forward convexity when at very low angles of incidence, depresses it, and thereby shifts the centre of pressure further back.

Drzewieki, a Russian engineer, who, by the way, appears to have a masterly grasp of the principles of true flight, has arrived at the conclusion that there is an angle—an exceedingly acute angle—for inclined aerial sustaining surfaces, at which "the horizontal component of air pressure, *i.e.*, the 'drift,' is constant at all speeds." This angle of constant pressure, however, is given as being only 1° 50′ 45″ with the horizon. It would demand, therefore, enormously high velocities to obtain any considerable "lift" with it; but, given the necessary velocity, it would doubtless prove very efficient.

The fact that all past experiments on that point have taught us that acute angles of inclination display greater efficiency than those that are steeper tends to confirm Drzewieki's contention; and the prevailing tendency with aero-dynamic experimenters now is to adopt lower angles than was the practice with those earlier in the field.

It need scarcely be remarked that the foregoing conclusion applies in an equal degree to rotating aerial propellers. Fine pitch, with proportionately higher speed of rotation, has invariably been found more efficient than coarse pitch, and consequent lower speed; under the former conditions that invaluable factor *air-inertia* is utilised to greater advantage. With further reference to aerial propellers, one of the present writers has found by comparative experiment that a very advantageous feature in their design is to make the blades concave on the driving side (and, therefore, convex on the other side), which form really amounts to extending the principle of the lifting aerocurve to propeller blades, which latter have hitherto been made flat: but more of this in its place.

Given such a design of aerial sustaining apparatus, either in combination with or applicable to a bicycle, as will secure the right relative position of centre of weight with centre of pressure of surfaces, together with the arrangement of those surfaces equally on each side of the longitudinal centre line at an upward or "diedral angle" of 15° each with the horizon transversely, and divided into two groups longitudinally, leaving a mid space occupied by the bicycle and rider, such a machine will be endowed with *automatic stability*—an imperative condition for the maximum degree of safety, as we have before urged—and having that property it will demand no effort of the rider to maintain its balance when air-borne. The factor of control of the machine when on the ground being attained, probably after many alterations and adjustments, the next step—in fact, *the* step—is to make an effort to get a lift, to leave the ground, to become wholly air-borne, and to "skim" or glide over it.

At this stage we firmly believe the bicycle will unmistakably demonstrate its practical value in this new application and its superiority to the means hitherto adopted.

It may now perhaps dawn upon the intelligence of the thinking reader that a practical and rather formidable difficulty may obtrude itself here and say "No go." That difficulty has not been overlooked, but anticipated. It is in effect as follows:

The reader may say: "But as your bicycle gathers speed, so will your surfaces gather 'lift,' and the weight on the road wheels becoming proportionately less and less, you will very shortly reach that point at which there will not be sufficient adhesion of the driving wheel on the road to effect propulsion of the machine, and there your bicycle will fail you, as that will be the limit of speed attainable."

Doubtless that is where we *should* "get left" if we took no steps to meet the difficulty.

The reader may be pardoned jumping to this conclusion, as he is not yet aware that in the special type and arrangement of lifting surfaces we propose using, the component aerocurves will be so constructed and mounted as to be either effective or neutral at will. This condition will be attained by making them capable of being moved through a small angle in their frames, *i.e.*, having two alternative positions, viz., zero, with the chord of the aerocurves inclined slightly downwards—that is, at a negative angle—and the other position that of the positive angle of maximum efficiency, the latter being found by previous experiment.

The aerocurves will be linked or coupled together, so that they can be shifted over simultaneously from "zero" to "lift" when it is judged that a sufficiently high speed has been attained. (See fig. 7.) As will be seen, the method is analogous to that employed with Venetian blind slats. The use of an aerial screw propeller—which would be an alternative to the foregoing method if provided with a motor of adequate power, but would continue the propulsive effort with only the air as an abutment instead of the unyielding road as the adhesion of the driving wheel on the latter decreased—we do not contemplate in the earlier experimental stage with which we are at present dealing, and in which it is proposed to use man-power only, but *not*,

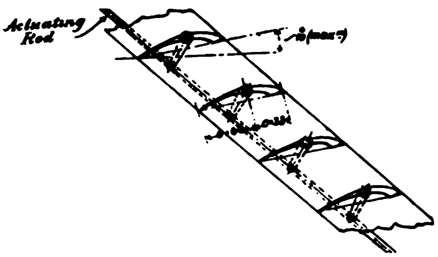

Fig. 7. Detail showing one method of "feathering" aerocurves (zero to 10° positive angle).

be it noted, with the expectation of attaining sustained or *continued* flight.

The power applied to the driving of an aerial propeller on a bicycle would not be nearly so effective in getting up speed on the machine as continued constant adhesion of the driving wheel on the road until the maximum speed attainable was reached. To exemplify this, let us consider the case of the big Maxim aeroplane machine which, as is generally known, was mounted on four flanged wheels running on horizontal rails. The twin steam motors of that experimental machine are said to have developed 360 h.p. collectively; the total weight of the machine on trial was about 8,000 lbs. Now, it seemingly required that large amount of power to propel the machine at a maximum speed of about thirty-five miles per hour through the medium of the propellers with aerial abutment only.

It is probable that *one-fifth* of that power, viz., 72 h.p., would have sufficed to propel the machine at the same speed if it had been applied to the flanged wheels on which it ran, supposing the necessary full adhesion on the rails to have been maintained. Where the propellers would have full scope for their efficiency would only be when the machine became finally air-borne.

In quoting the foregoing example we are by no means asserting that the 72 h.p. would be adequate to effect a sustained lift of that weight with a machine of that type, but rather that a positive abutment, such as that afforded by the adhesion of wheels on either road or rails, such wheels being driven direct by the motor, would effect propulsion at a given speed (apart from lifting) with much less expenditure of power than in the aerial abutment method.

Besides the bicycle in combination with the apparatus of sustentation, and inseparable from it when in use, we have in mind also an alternative arrangement. This is one in which the aerial apparatus, comprising the sustaining aerocurves and their framing, together with the rider, is detachable at the will of the rider when lifting from the bicycle proper. (Fig. 8.)

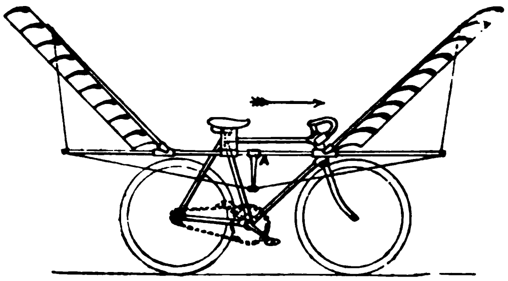

**Fig. 8. Bicycle with self-detachable soaring machine, saddle and handle-bar carried on the latter.**

**A, parallel trussed tubes (near together).**

NOTE.—Aerocurves are sloped at a "diedral angle" of 150 transversely. The soaring frame lifts clear of bicycle.

This arrangement has the advantage of reducing the weight to be lifted to the extent of the bicycle's weight, and thus admitting of a proportionate reduction of the area of lifting surface. This form of apparatus may prove in practice to be at a disadvantage in one respect compared with the former non-detachable type, inasmuch as the landing will have to be effected on foot under somewhat similar conditions to those that prevailed with the soaring apparatus of Lilienthal and Pilcher. It will have, however, all the advantage of the preliminary smooth swift run on wheels.

In this method it is essential that the temporary connection with the bicycle be such that the soaring moiety of the machine shall have a clear and undisturbed release from the bicycle frame, which release, if it is found desirable on trial, can easily be effected automatically.

Supposing the necessary lift obtained and the cycle detached, it is not anticipated, of course, that continuous, or even sustained, flight will ensue in the elementary motorless experiments;. but we *do* expect that, on suitable ground, glides of considerable length will be safely effected—in fact, of such duration and range as will compare favourably with those of the other experimenters by the methods extant.

In the initial stage, these, our advocated experiments, involve only temporary passive flight at the most: but, as we have seen in the interesting evolution of the bicycle, the results attained with the painfully primitive "dandy-horse" were very meagre compared with those produced by that triumph of mechanical development—the cycle of to-day. A racing cyclist in a short spurt at top speed develops a considerable amount of power—probably at the rate of 20,000 foot-pounds (or 0.6 h.p.) per minute—and if an experimenter in flight were by one big effort able to raise the detachable gliding apparatus one foot above the position in which it was carried on the bicycle, the flight problem would be in a fair way of practical solution. The foregoing assumes that all due attention had been paid to that vital property *automatic stability* in the design of the apparatus. In this respect again the system we now advocate should score largely.

The rider would learn something in ten seconds clear of the earth on such a machine, and knowledge of that practical sort would be followed by practical improvements in the combined machine itself.

It is true that gliding experimenters have been in the air for as long as, or longer than, ten seconds, but the fact that they were only infantry, so to speak, *i.e.*, unmounted, and, therefore, unable to propel their machines efficiently, alters the case very materially. The difficulty and the proportionate advantage of cycle propulsion offer a useful parallel, and the driven gliding bicycle would behave differently—possibly be easier to handle than the pedestrian types of gliding machine.

The rise obtained by a great effort might be spread over a rather long range or glide in descending if some propulsive effort (when air-borne) assisted—or, rather, continued—the initial impulse. This would *flatten the angle of descent.*

If larger power were applied to act when "on the wing," the result should be sustained horizontal, or even *rising*, flight.

Assuming that the intelligent experimenter has now devoted adequate skill, time, and untiring practice—in short, has quite familiarised himself with the management and behaviour of the machine in its simpler form—it may now be in order to consider the application of motor power.

*(To be continued.)*

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The quite recent soaring and gliding practice of the brothers Messrs. W. and O. Wright in North Carolina, U.S.A., indicates great and encouraging progress beyond any previous performance of their own or of others. They find it practicable and advantageous to increase the already large area of surface (305 square feet) in their novel type of apparatus, and find it more manageable than their last year's machines. They are able to guide it upward, downward, or broadside on, with ease and certainty, effecting thousands of glides without accident. The angles of descent are much flatter—as low as 6° with the horizon—and prolonged glides follow as a consequence.

# Recent Disasters and the Factor of Safety.*

IN calling attention to the recent disasters which have occurred in Paris, I do so in order that those students of aeronautics who are attempting practical experiments may be persuaded to take every reasonable precaution to anticipate and, where possible, *arrange* to avert the results of possible accident. Severo lost his life through designing his craft with the petroleum motors too near to the gas exhaust, and owing to the nature of the accident, it is difficult to see how, an explosion having occurred, it was possible to escape the resulting fall. Baron de Bradsky's mishap, however, might not have proved fatal if he had taken the precaution to have at hand the ordinary parachute which has been in use for many years.

There are distinctly two methods of avoiding fatal accident when one's displacement apparatus has collapsed, viz., *parachute surfaces and cushioning.* With regard to parachute surfaces for the individual, I hold that resort should be made to these only in the last extremity. The first consequence of a fall should be the automatic placing in position of large checking surfaces which should be of sufficient area to retard the descent, and, in fact, save the whole airship from destruction. They can easily be so designed that, when not required, they can be stowed away folded, for instance, somewhat on the pattern of a venetian blind; while the upward run of air resulting from a fall at great speed would act upon inclined planes so set that they liberate the surfaces and force them into extension. The position should be, of course, as far as possible above the centre of gravity, but below the balloon, to avoid possible disarrangement in case of this becoming unevenly deflated.

It is well to bear in mind that a man must be provided with apparatus that will restrain his fall to perhaps twenty feet per second; but cushioning can be resorted to in the case of a machine, and half the proportionate amount of surfaces will be found to suffice.

Regarding the problem of cushioning the blow resulting from violent contact with the earth, very few airship designers take this necessity into consideration. With the long frail car necessitated by the new type of balloon, it is very important that landing should be effected very gently, and springs, whether metal or compressed air, should be provided. Let me instance the jumping sheet in use by our fire brigade as a splendid example of this provision. A leap from a height of fifty feet is made in perfect safety, the force generated being taken up through a compression of perhaps four to six feet. Why not provide our machines with pistons and rods travelling in cylinders with controllable exhausts? An exhaust for this purpose would be an improvement to a closed cylinder. I think it would effectually prevent the rebound. There should be no difficulty in making this cushion meet the ground first; the damaged balloon fabrics, etc., would keep the car from revolving on its horizontal axes.

Again, it should be possible in a case of great emergency to relieve the balloon of the weight of the car, engines, etc. The whole should be detachable by the pulling of a lever, leaving the aeronauts upon a very light frame. It must be remembered that recourse has been found necessary in many cases of urgency to cutting away the car. Such an alternative will not be available with our airships unless particular attention is paid to this requirement in the original design.

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* Paper by Mr. O. C. Field, read before the Aeronautical Institute and Club, Nov. 7th.

Another element of safety must not be overlooked. Do not let us have all our buoyancy in one chamber. In this connection, the twin balloon of Mr. Andersen, and the gas-tight compartments included in Dr. Barton's war balloon, are both admirable.

If the worst happens, and a descent is being made at a dangerous speed, how should a man pose to meet the shock? In ordinary descents it is customary to bend the knees and hold above the head with the hands, the arms not being fully extended. Has the suggestion been made that it might be best to take up a horizontal position? The blow would be taken up by perhaps ten times the surface, and, in addition, there would be not nearly the same chance of breaking bones.

As showing the necessity for this movement in regard to safety, a search at the Patent Office reveals the fact that not two per cent. of inventors pay any consideration to the necessity of providing their inventions with parachute surfaces or similar apparatus. Dr. Barton is alive to the importance of this point, as is also another member of the Institute, Mr. T. D. Cook, a medical man at Torquay. Credit is also due to Mr. Glendinning, the collier balloonist of Bridlington, for tackling the problem of the combined balloon and parachute.

Relative to the aeronautical exhibition during the coming year, we might include a series of contests between parachute models. Members of the Aero Club have indulged in balloon-racing and chasing. The Aeronautical Society have announced a kite competition. Why should not the Aeronautical Institute revel in a kind of parachute donkey race—last man home to win? The knowledge thus gained would be valuable and well worth recording. To genuine students of the problem such a competition would convey much; for example, Smeaton's laws regarding pressure of wind per square foot on surfaces met at right angles could easily be tested by this very simple method.

I have suggested only a species of scratch races; we might have, in time, handicaps, dimensions, weights, design, etc., all at the option of the inventor. An expert handicapper would then possess knowledge pertaining to aeronautics which would cause him to be looked upon as an authority, and his knowledge should be very valuable.

### REMARKS.

Mr. Aug. Gaudron then gave a few particulars of the ordinary parachutes, stating that surfaces of, roughly speaking, one square yard, were allowed for each 2 lbs. of weight to be supported. There would be no difficulty in clearing the cars when used in emergency. The parachutes would be attached lightly at convenient places, and the act of throwing the weight of a man's body on them would break them away, the descent automatically opening them.

Dr. Barton thought there would be considerable difficulty in designing a lever which could disengage the car with sufficient promptitude. He was not in favour of the horizontal method of receiving the ground shock.

Messrs. Alderson, Blanchard, Holtorp, and Senecal also took part in the discussion, Mr. Blanchard speaking strongly in favour of the automatic "ship parachutes."

Replying to his critics, Mr. Field stated that he considered that means of detaching the car by some modification of the lever could readily be provided. He thought that a centre rod to the ordinary parachute would be an improvement, steadying the apparatus—being, in fact, a fixed keel as compared with a slung weight. He was endeavouring to introduce the principle of the lever to increase the equilibrium. He had mentioned the jumping sheet, as this was an example which gave some indication of the necessary amount of stroke of piston in the cushioning cylinders; or, if pneumatics were not adopted, then the amount of "take up" to be allowed for in the springs. As regards the objection which one member had raised—that the detached car would "lay out the block"—he (Mr Field) would ask that gentleman to say whether he did not consider it better that the car alone should fall, with the likelihood of no lives being lost for it is only occasionally that a balloon voyage is made over a thickly-inhabited district—than that car, crew, and the whole apparatus should drop, with the certainty that in any case the lives of the crew would be forfeited. Mr. Field again impressed upon his audience the necessity of giving every consideration to suggestions whereby a fatal accident might be avoided.

A vote of thanks to the lecturer was proposed by Mr. P. L. Senecal, seconded by Mr. C. H. M. A. Alderson, and carried.

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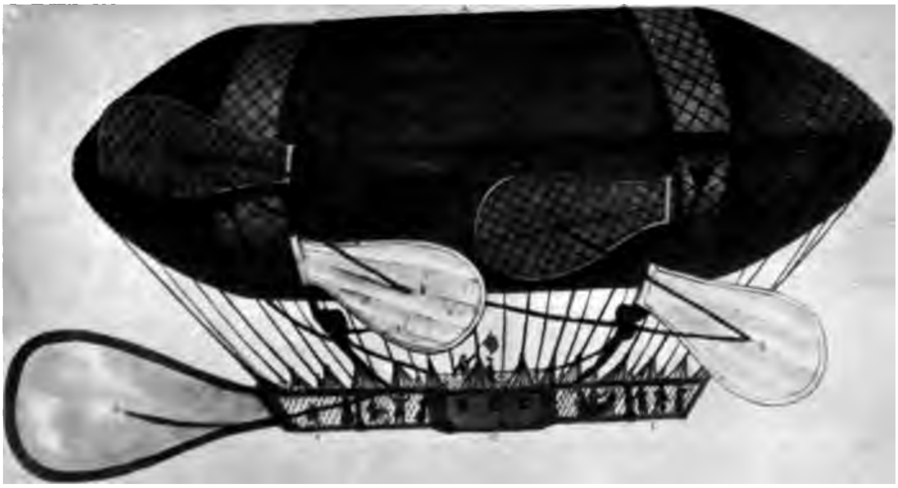
A French officer has evolved an aeroplane, built on the modified lines of a sea-gull, partly made of aluminium and partly of a material invented for the purpose, propulsive power being supplied by a petrol motor placed in the centre of the frame. "Crossing the Mediterranean at a speed of fifty miles an hour," the inventor thinks, will prove the superiority of his ornithological understudy.



THE EAGLE.

Exhibited at the grounds of the Aeronautical Society, Victoria Road, facing Kensington Gardens, in 1835. Designed for establishing a direct communication between the capitals of Europe The machine was 160ft. long, 30ft high, and 40ft. wide. A, body of vessel capable of containing 2,700 cubic feet of gas; B, wings, four on each side. C, cabin containing machinery for working the wings. D, rudder E, extremities of the car, which was made of wood, and was 75ft long and 6ft. wide.

# The De Bradsky Catastrophe.

SOON after the publication of our last issue Paris was the scene of a motor balloon catastrophe which in many respects had a strange resemblance to the fate that befell the Pax of Senor Severo, though due to entirely different causes. Baron de Bradsky was a young enthusiast in motor ballooning, who had gone from Saxony to the French capital, where he hoped to profit from the greater facilities for the construction of navigable balloons than were possible elsewhere. He did not agree with the theories most generally in vogue, that a motor balloon or flying machine should be lighter or heavier than the air, and his idea was to effect a compromise by making his airship practically of the same weight as the volume of air it displaced, so that without any mechanical elevating force it would not have sufficient buoyancy to rise. As a matter of fact, the balloon had a certain buoyancy, which was overcome by sand ballast, and it was thus designed as a precaution against accidents, so that in the event of anything going wrong the balloon could be raised by throwing ballast overboard until it could descend safely. It was fitted with a 16 h.p. Buchet motor, which gave motion to two propellers —a horizontal one beneath the keel and a vertical propeller at the end for driving the balloon forward. Baron de Bradsky was assisted in his experiments by a French engineer, M. Morin, who was a prominent figure in the automobile world. The balloon was constructed in the same shed that had previously sheltered the ill-fated Pax, and when it ascended early in the morning with Baron de Bradsky and M. Morin on board the spectators had an uncomfortable impression that it was undergoing the same inexplicable evolutions as Senor Severo's machine. Instead of going in the direction of the drill grounds at Issy, the balloon drifted away over Paris, passed above the Opera, and finally disappeared in the morning mist, when it appeared to be making for the Plain of St. Denis. It was carried beyond St. Denis, and when out in the open country it was at a height of about a hundred yards. A man working in the fields was hailed by one of the occupants, who asked where there was a convenient landing-place. This was pointed out to him, and a few minutes later there was a crash as the keel suddenly detached and fell to the ground, while the balloon rose rapidly in the air. Baron de Bradsky and M. Morin were killed instantly. The keel was a complete wreck, and presented nothing but a mass of twisted tubes and wires. The accident was evidently due to the defective way in which the wires were attached to the wooden frame. The ends had merely been twisted round, and it is concluded that as the balloon was pointed up or down the heavy strain put on the end wires caused them to unwind, and finally the whole of the wires slipped just at the moment when the unfortunate aeronauts were preparing to descend.

As some adverse criticisms have been made on the aerostat in which the late Baron de Bradsky lost his life, some further details of this machine will be of interest to our readers. Looking at the machine from an engineering point of view, it strikes one as being a far more successful piece of workmanship than some of the frail structures which have up to the present been the victorious machines. Though designed to balance the amount of air displaced, the lifting being done by vertical propellers, the gas bag was also capable of supporting or lifting independently. This had a total length of 110ft., its diameter being 21ft. and cubic capacity 1,010 yards. The envelope was of fine light Japan silk, being pointed at the forward end and rounded at the stern—a shape somewhat similar to that adopted by Count Zeppelin. To prevent the balance being upset, and to prevent bursting strains, the envelope was divided into three nearly equal compartments independent of one another. At the rear of this was a rudder having an area of about three square yards. It was constructed with a light steel frame, over which specially strong silk canvas had been stretched. The control of the rudder was by means of cords running down into the car, and these were under the direct control of the operator.

Around the envelope and attached to it was a light wooden frame or beading, and to this the car proper was attached by means of steel piano wires. The car itself was 55ft. long, including the propeller, 4ft. high, and 4ft. wide amidships. The motor and the platform proper were at the centre, whence the car tapered away at both ends, as shown by the plan, fig. 1. The elevation of the car, fig. 2, was similar to the plan, so far as the taper part of the construction was concerned. The whole of this part of the machine was constructed of steel tubes, varying from ½in. to 1in. in diameter, the thickness of the tubes being 0.04in. This construction gave a very rigid car, though not too heavy. The frame was further braced up by duplex steel wires, very tightly tensioned, and there is hardly a shadow of a doubt that it was the vibration, set up by the air currents, upon these wires which caused the collapse of the machine. We venture to express the opinion that had the frame been braced otherwise than by wires or cords the machine would have successfully accomplished its journey.

The two propellers H and I were driven through reducing gears G and J respectively by a 16 h.p. four-cylinder Buchet motor. There are no particular features about this motor, it being to standard design, weight having been cut down to the lowest possible point. The horizontal propeller was 13ft. across it, and was built on the same principle as the rudder. It revolved at a speed of 300 revolutions per minute, driving the airship forward. The vertical ascensional propeller measured about 8ft. across, and worked at 350 revolutions per minute, its function being to lift the weight.

The diagram of the mechanism is almost sufficiently clear to make it self-explanatory. The motor A gave motion to the mainshafts D D through the clutch B to the horizontal propeller and C to the vertical propeller. Both shafts were carried in ball bearings specially designed by the inventor, these being tied to the triangular frame by screw tensional wires—a weak design. These are indicated by E repeated. The clutches were independent of one another, and were separately controllable by the operator through the handles K and L respectively.

The reduction of speed to the horizontal propeller I was obtained by a plain spur gear J, and to the vertical shaft F and propeller H by a bevel gear G.

The aeronaut's platform was constructed of wickerwork, and gave accommodation for two passengers. With regard to the equipment of the motor, the water-cooling radiators were very light, only three gallons of water being carried. The same quantity of petrol was also carried. Two carburetters were used, one to serve each pair of cylinders, each of which had a separate exhaust. These exhausts were about 18in. long by 3in. diameter, and the outer end alone was perforated. It was thought that by this arrangement the risks arising from the exhaust gases would be minimised.

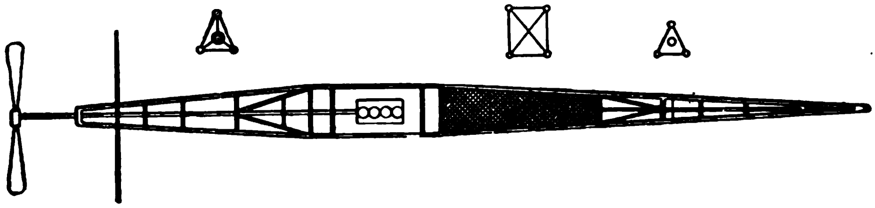


Fig. 1.—Plan of the airship The diagrams above are the sections of the frame opposite to them

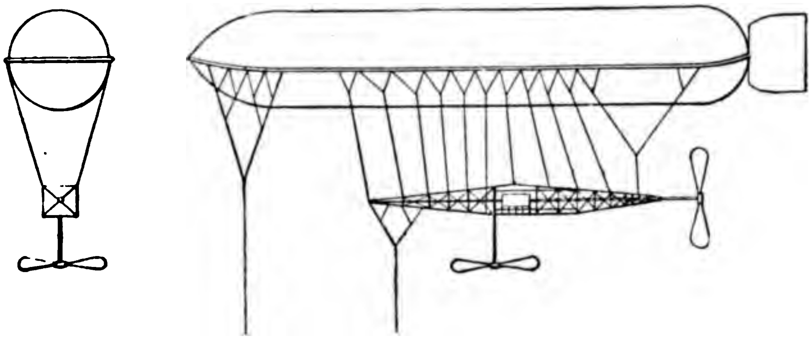


Fig. 2.—Elevation of the airship.

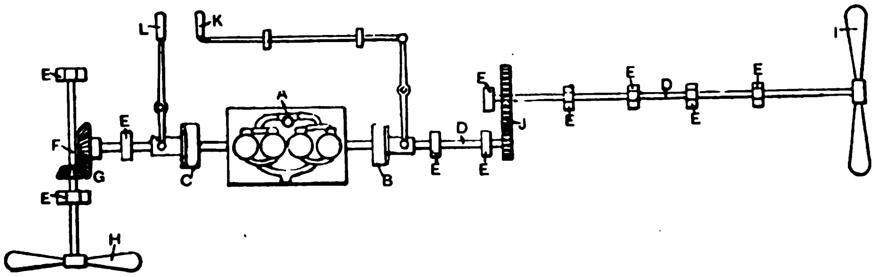


Fig. 3.—Plan of the driving mechanism.

A, motor.
B, clutch to horizontal propeller
C, clutch to vertical propeller.
D D, main drivingshafts.
E (repeated), bearings for shafts D D
F, vertical propeller-shaft.
G, reducing bevel gear for F.
H, vertical propeller.
I, horizontal propeller.
J, reducing gear to horizontal propeller.
K, controlling handle.
L, .. ,

A Swedish aeronaut has built a balloon of peculiar construction, which made its maiden ascent from Stockholm, starting at a speed of thirty miles an hour. A difficult but successful descent was made at a desolate spot in Russia, eighty miles south of St. Petersburg.

After a series of experiments, it has been decided to substitute kites for the balloons now used on board vessels of the Russian navy for purposes of observation. Five kites are sufficient to lift a man high enough to give him a range of ten miles of observation.

# Inventors and the Flying Machine.

IN the course of a lecture on this subject, before the Aeronautical Institute, on November 7th, 1902, Mr. E. C. Dwyer said:

There are inventors who hope to further the progress of aerial flight with the help of the navigable balloon, and in time to arrive at the true flying machine, and these inventors answer, when the danger and disadvantage of the gas bag are pointed out to them, that at the present time it is the only way of gaining experience, and that by using it they are enabled to observe the behaviour of craft in the air; by improvement and modification, they hope in time to bring their machine to such perfection that the balloon becomes unnecessary. How far is this position tenable? Will the experience gained with the navigable balloon be of much use when, if ever, the gas bag is put aside? Are not the problems which the balloon introduces such that their solution will be of very little use when applied to heavier than air machines? Is not the behaviour of propelled balloons so erratic that even if the difficulties are overcome more or less the means used to overcome them cannot be made to answer like purposes in the " true flying machine "?

For instance, take the question of propulsion. The balloon, being only a floating gas bubble, with an envelope of very light fabric, when driven through the air at even a moderate speed, cannot from its very nature resist distortion; and although various inventions have been brought out for keeping balloons in shape, yet up to the present no fairly satisfactory test can be said to have taken place, and only when a balloon is driven at, say, forty miles an hour will the enormous strains set up by the gas bag wanting to go in an opposite direction to the car be fully gauged. All the difficulties of propulsion in a navigable balloon are connected with the gas bag—how to prevent it changing its shape, making it strong enough to resist wind pressure, etc.—so that it can readily be seen that all the experience gained in overcoming these difficulties—which might be called the *vital* points—will be useless when applied to a heavier than air machine.

Is the balloon such a safeguard when attached to flying machines as it is made out to be? Is the hanging of heavy machinery to a bag of gas which has an enormous surface exposed to sudden gusts of wind guarding against disaster or courting it? In recent accidents we see a great deal made out of the inexperience of the aeronauts; but are aeronauts of *free* balloons in a better position than the engineer to guard against disaster in the navigable balloon? The conditions are entirely different.

It is extremely doubtful whether the flying machine will be the product of one man's brain. Looking back at the great mechanical inventions, we see they have been built up gradually: they did not come forth full-fledged as it were, but given the correct basis to work upon there have always been persons ingenious enough to improve and supplement until the machine becomes as perfect as possible.

In the flying machine, what we want is the correct basis to work upon. Given that, we shall be able to produce a successful flying machine. To produce a machine to accomplish a specified purpose, that purpose must be fully grasped if the inventor hopes for success. Granted that a man did produce a workable flying machine, the odds are that he would spend his lifetime in perfecting it, and most likely his fortune too, or, if not his own, somebody else's, if he was lucky enough to get hold of it. The class of inventors who are most likely to benefit are the improvers—those who perfect the details and introduce fresh ideas which help to perfect the machine.

The fascination of aerial flight has been responsible for many past disasters; but it is to be hoped that a better study of the conditions under which the machine has to perform its work will lessen the risk run by the pioneers in aeronautics.

The flight of birds has been greatly studied, especially in America, and there machines based on the bird are very common; but in this connection there is one very potent factor that cannot and must not be overlooked, namely, life. Although we may study the wings of birds, the arrangement of their feathers, the method of flapping, and many other details, and then construct a model on these lines, we can never hope to get the same results as a bird; and why? The answer is that birds must exert, consciously or unconsciously, a lifting effort, which, by the help of their wings, enables them to fly

Those inventors who have built machines on the bird principle have used the same method of flapping the wings. They are fixed to a fulcrum, and the outside edges describe a circular path through the air, as in a bird. In bringing forward a few suggestions for a flying machine, I do not claim any originality for the scheme, as there may be those who will say the machine was known five hundred years ago. But it seems to me that if we want to get a lifting effect by means of wings the method described is not the most efficient way of doing it. I suggest that in place of flapping the wings as a bird does, they should make the required stroke flat; that is, the whole of the wing should descend. This would give absolutely the best lifting effect that it is possible to arrive at, except perhaps the aeroplane driven at a great speed. The whole surface thus becomes active and utilised. If we also make them slightly concave, there would be very little slip; in fact, not more than in a parachute. The mechanical difficulties ought not to be very great—not greater than in the case of machines with the usual flapping wings. I believe wings of the shape described could be made much stronger than those of the usual type, as the two wings would be on one framework, and by this arrangement the wings would descend at the same instant, on the upward stroke. Devices could be used for relieving the back pressure. It might be more effective to have the wings inclined at a slight upward angle in the direction the machine is to travel. By this means the wings would have an aeroplane action relative to the speed, and at the same time a lifting effect due to their downward stroke. This angle would of necessity have to be very slight. In addition to these wings, I should suggest that fixed aeroplanes be placed above them of about the same area, which would help to buoy the machine on the upward stroke of the wings. The shape of the framework, which would be rectangular, enables it to be extremely strong and at the same time light.

Although this type of machine is only a suggestion, I believe that, given the same area of wing surface and the same power, a greater lift could be got by its use than by the usual method of flapping wings. There is also the great question of balance; but I think that if a machine could be got to sustain the required weight above the ground, it would not be long before an automatic balancing apparatus was produced. The machine could be propelled by screws or some similar device, and there would not, I think, be any difficulty about this.

To my mind there is absolutely no reason to follow the structure of the bird, as has been done in the past, as, after all, what is wanted is the best way to obtain a lifting effect, and, mechanically, the way the bird does it is not the most efficient, soaring being left out of the question.

A long discussion followed, and a hearty vote of thanks was accorded to Mr. Dwyer for his paper.

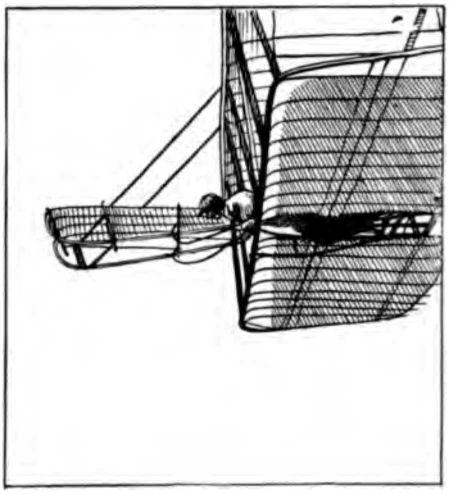
# Some Aeronautical Experiments.

## A Paper read by Mr. Wilbur Wright, Dayton, Ohio, before the Western Society of Engineers.

*(Continued from page 191.)*

We were unable to obtain direct measurements of the horizontal pressures of the machine with the operator on board, but by comparing the distance travelled in gliding with the vertical fall, it was easily calculated that at a speed of twenty-four miles per hour the total horizontal resistances of the machine, when bearing the operator, amounted to 40 lbs., which is equivalent to about 2⅓ h.p. It must not be supposed, however, that a motor developing this power would be sufficient to drive a man-bearing machine. The extra weight of the motor would require either a larger machine, higher speed, or a greater angle of incidence, in order to support it, and therefore more power. It is probable, however, that an engine of 6 h.p., weighing 100 lbs., would answer the purpose. Such an engine is entirely practicable. Indeed, working motors of one-half this weight per horse-power (9 lbs. per horse-power) have been constructed by several different builders. Increasing the speed of our machine from twenty-four to thirty-three miles per hour reduced the total horizontal pressure from 40 lbs. to about 35 lbs. This was quite an advantage in gliding, as it made it possible to sail about fifteen per cent. further with a given drop. However, it would be of little or no advantage in reducing the size of the motor in a power driven machine, because the lessened thrust would be counterbalanced by the increased speed per minute. Some years ago Prof. Langley called attention to the great economy of thrust which might be obtained by using very high speeds, and from this many were led to suppose that high speed was essential to success in a motor-driven machine. But the economy to which Prof. Langley called attention was in foot-pounds per mile of travel, not in foot-pounds per minute. It is the foot-pounds per minute that fixes the size of the motor. The probability is that the first flying machines will have a relatively low speed, perhaps not much exceeding twenty miles per hour, but the problem of increasing the speed will be much simpler in some respects than that of increasing the speed of a steamboat; for, whereas in the latter case the size of the engine must increase as the cube of the speed, in the flying machine, until extremely high speeds are reached, the capacity of the motor increases in less than simple ratio; and there is even a decrease in the fuel consumption per mile of travel. In other words, to double the speed of a steamship (and the same is true of the balloon type of air ship) eight times the engine and boiler capacity would be required, and four times the fuel consumption per mile of travel; while a flying machine would require engines of less than double the size, and there would be an actual decrease in the fuel consumption per mile of travel. But looking at the matter conversely, the great disadvantage of the flying machine is apparent, for in the latter no flight at all is possible, unless the proportion of horse-power to flying capacity is very high; but, on the other hand, a steamship is a mechanical success, if its ratio of horse-power to tonnage is insignificant. A flying machine that would fly at a speed of fifty miles an hour with engines of 1,000 h.p. would not be upheld by its wings at all at a speed of less than twenty-five miles an hour, and nothing less than 500 h.p. could drive it at this speed. But a boat which could make forty miles per hour with engines of 1,000 h.p. would still move four miles an hour, even if the engines were reduced to 1 h.p. The problems of land and water travel were solved in the nineteenth century, because it was possible to begin with small achievements, and gradually work up to our present success. The flying problem was left over to the twentieth century, because in this case the art must be highly developed before any flight of any considerable duration at all can be obtained.

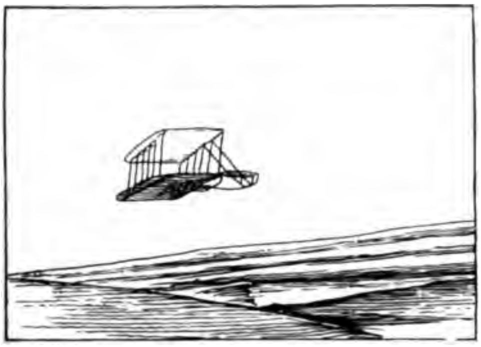
However, there is another way of flying which requires no artificial motor, and many workers believe that success will first come by this road. I refer to the soaring kite, by which the machine is permanently sustained in the air by the same means that are employed by soaring birds. They spread their wings to the wind, and sail by the hour, with no perceptible exertion beyond that required to balance and steer themselves. What sustains them is not definitely known, though it is almost certan that it is a rising current of air. But whether it be a rising current or something else, it is as well able to support a flying machine as a bird, if man once learns the art of utilising it. In gliding experiments it has long been known that the rate of vertical descent is very much retarded and the duration of the flight greatly prolonged, if a strong wind blows *up* the face of the hill parallel to its surface. Our machine, when gliding in still air, has a rate of vertical descent of nearly six feet per second, while in a wind blowing twenty-six miles per hour up a steep hill, we made glides in which the rate of descent was less than two feet per second. And during the larger part of this time, while the machine remained exactly in the rising current, *there was no descent at all, but even a slight rise.* If the operator had had sufficient skill to



Soaring.

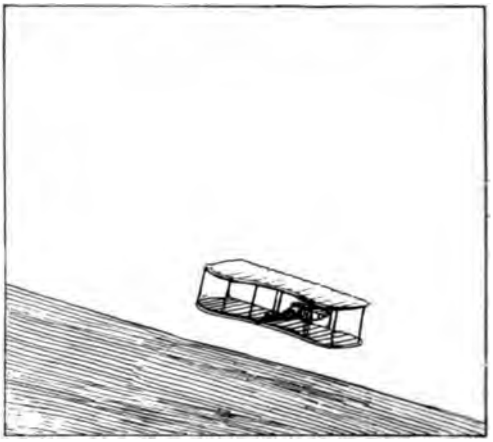
keep himself from passing beyond the rising current, he would have been sustained indefinitely at a higher point than that from which he started.

These slow glides in rising currents probably hold out greater hope of extensive practice than any other method within man's reach, but they have the disadvantage of requiring rather strong winds, or very large supporting surfaces. However, when gliding operators have attained greater skill, they can, with comparative safety, maintain themselves in the air for hours at a time in this way, and thus by constant practice so increase their knowledge and skill that they can rise into the higher air and search out the currents which enable the soaring birds to transport themselves to any desired point by first rising in a circle and then sailing off at a descending angle. This illustration shows the machine, alone, flying in a wind of thirty-five miles per hour on the face of a steep hill 100 feet high. It will be seen that the machine not only pulls upward, but also pulls forward in the direction from which the wind blows, thus overcoming both gravity and the speed of the wind. We tried the same experiment with a man on it, but found danger that the forward pull would become so strong that the men holding the ropes would be dragged from their insecure foothold on the slope of the hill. So this form of experimenting was discontinued after four or five minutes' trial.



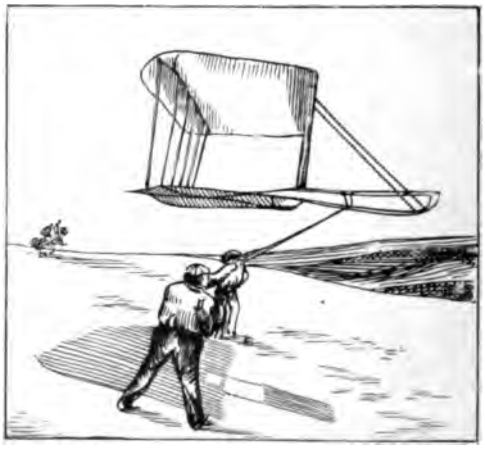
A high glide.

In looking over our experiments of the past two years, with models and full-size machines, the following points stand out with clearness:



A low glide.

1. That the lifting power of a large machine, held stationary in a wind at a small distance from the earth, is much less than the Lilienthal table and our own laboratory experiments would lead us to expect. When the machine is moved through



Kite soaring.

the air, as in gliding, the discrepancy seems much less marked.

2. That the ratio of drift to lift in well shaped surfaces is less at angles of incidence of five degrees to twelve degrees than at an angle of three degrees.

3. That in arched surfaces the centre of pressure at ninety degrees is near the centre of the surface, but moves slowly forward as the angle becomes less, till a critical angle varying with the shape and depth of the curve is reached, after which it moves rapidly toward the rear till the angle of no lift is found.

4. That with similar conditions, large surfaces may be controlled with not much greater difficulty than small ones, if the control is effected by manipulation of the surfaces themselves, rather than by a movement of the body of the operator.

5. That the head resistances of the framing can be brought to a point much below that usually estimated as necessary.

6. That tails, both vertical and horizontal, may with safety be eliminated in gliding and other flying experiments.

7. That a horizontal position of the operator's body may be assumed without excessive danger, and thus the head resistance reduced to about one-fifth that of the upright position.

8. That a pair of superposed or tandem surfaces has less lift in proportion to drift than either surface separately, even after making allowance for weight and head resistance of the connections.—*Journal of the Western Society of Engineers.*

**VIEW OF THE WORKHOUSE AND INFIRMARY AT LOCK'S BOTTOM, BROMLEY, KENT.**
**Taken from a height of 500ft.**

# The Safety of Airships.

AT the November meeting of the Aeronautical Club and Institute, Dr. Barton, the president, made the following communication on the above subject:

During the past few months we have had to mourn the loss of two brave aeronautical inventors, Senhor Severo and Baron de Bradsky, and their two companions; but the details of those accidents, which have been fully described in the English and French papers, are probably known to most of you, and I shall therefore not take up your time by entering into them. The question, however, which concerns us is: Could these accidents have been foreseen and prevented by taking due precaution? I have not the slightest hesitation in saying that they could. Mons. Lechambre told me that he had warned Senhor Severo about the dangerous proximity of the motor to the neck of the balloon, and it is reported that Mons. Santos-Dumont cautioned Baron de Bradsky as to the faulty construction of his apparatus, and more particularly as to his method of suspending the car from the balloon.

Consider the qualifications necessary for an inventor of a machine for navigating the air.

1. He ought to be an experienced aeronaut, to have made several ascents in charge of an ordinary balloon, so as to be thoroughly acquainted with the rapid changes which take place in the atmosphere, and to know what to do in cases of emergency.

2. He ought to have a good knowledge of meteorology, to have studied the aspect of the sky and clouds under varying conditions of weather, so as to be able to interpret the same and forecast with reasonable accuracy coming storms and change of wind.

3. He ought to be acquainted with the general principles of the motive power he intends to employ, whether electricity, steam, petrol, acetylene, or liquid air, and to know thoroughly every detail in the construction and working of the actual motor he uses.

4. He ought to have a knowledge of engineering construction, and be able to work out problems in the higher branches of mathematics, statics, and dynamics, so as to be able to calculate with absolute accuracy the strains and stresses on every part of his machine under the two conditions of rest and motion.

Now, I venture to say that at the present time there is not one man in a million who possesses all these qualifications, although very many may possess two or even three out of the four; and, considering the large number of inventors who are at present working on this fascinating subject, and the still larger number there will be in the immediate future, it seems to me that the most appalling accidents must happen unless something is done to prevent them as far as is humanly possible.

With regard to ships on the sea, no one, of course, can say that a ship will not be wrecked, however carefully designed and however well it may be captained and manned; but every ship intended for the conveyance of passengers and merchandise is obliged to be examined by experts and registered after the experts have reported that the ship is properly built and well found, that due precaution has been taken to prevent its sinking in case of a collision, and that there is ample life-saving apparatus for passengers and crew in case of a total wreck. The captain and officers, moreover, have to hold certificates that they have had the requisite training, and possess sufficient experience and knowledge to navigate such a ship.

Our excellent and energetic secretary, Mr. O. C. Field, must have had some such idea as this in his mind when he brought forward a scheme which was discussed and approved of by the executive committee of the Aeronautical Institute at a meeting specially convened for that purpose.

The scheme is, briefly, as follows:

1. That there should be a Central Board of Aerostation, who would have power to issue certificates to those aeronauts who by past experience were able to take charge of an ordinary balloon.

2. That the Central Board should appoint a committee of experts to examine all navigable balloons, flying machines, and airships generally, and to report thereon.

3. That the Central Board, acting on the report of the experts, should issue a certificate to the inventor, owner, or maker of such machine.

*(a.)* If the certificate states that the machine is well and properly constructed, that every precaution possible has been taken for the safety of the passengers and crew, and that the aeronaut in charge is properly certificated, then, in the case of an unforeseen accident, the inventor, owner, or maker shall not be liable.

*(b.)* If the certificate is issued subject to certain alterations in the construction, or to certain limitations as regards height or speed of travelling, then, if those limitations are exceeded, the alterations are not made, or no certificated aeronaut is in charge, if an accident happens the inventor, owner, or maker shall be criminally liable as having shown gross negligence.

*(c.)* The inventor, owner, or maker shall in like manner be liable to a criminal prosecution if he refuse to allow the experts to examine the machine before it is sent up with a crew.

*(d.)* If, after being examined by experts, a certificate is refused on the ground that the machine is absolutely impracticable and dangerous to human life, and the inventor, owner, or maker attempts to experiment with it, the Board shall have power to treat him like any other homicidal or suicidal lunatic.

Such are the general principles of the scheme which I have the honour of putting before you. If you approve of it, as I feel sure anyone must who has the welfare of his fellow creatures and the advancement of aeronautics at heart, we shall ask members of the Aero Club and of the Aeronautical Society of Great Britain, which is the oldest society of its kind in the world, to meet members of our committee in conference, when we shall go thoroughly into the scheme, and work out the necessary details, after which we will bring the whole matter again before you at a future meeting.

Several members spoke strongly approving of the broad outlines of the scheme, and it was decided to go into the matter on a future occasion.

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Mr. Eric Stuart Bruce, the honorary secretary of the Aeronautical Society of Great Britain, has always taken a keen interest in aeronautics, one of the aspects which has engaged his special attention being the signalling from balloons. In July, 1886, he applied electricity to a captive balloon, so that signals might be flashed from it by means of an apparatus on the ground.

# Flying Machines.

As the subject of the concluding lecture of the course on locomotion, which he has recently delivered at the Royal Institution in London, Professor Hele-Shaw chose aerial locomotion, and described the varying methods by which men in different ages have tried to fly. He demonstrated with the aid of a number of instantaneous photographs that flight entails great effort on the part of a bird, and pointed out that many of the so-called attempts at human flight have been in reality attempts to soar for which, as is shown by the prolonged time that a seagull can remain in the air without moving its wings, power of self-propulsion is not needed. Pictures of some of the earliest forms of wing contrivances for human support in the air were shown, and the lecturer, with the aid of an aeronaut who has made four hundred descents with a parachute, falling in some instances at least a mile, explained the method of using that contrivance, and, to indicate its liability to accident, mentioned that at least a score of people have been killed in attempting to make parachute descents. The swaying of parachutes while falling has been lessened very considerably by making a hole in the top of the umbrella-shaped contrivance, and this has served to make parachutes act more successfully in recent years than they were wont to do. In modern attempts to construct flying, or, to speak more accurately, soaring machines, an endeavour is made to obtain and utilise plane action, which Professor Hele-Shaw illustrated by the flight of a card edgewise through the air, pointing out how prolonged was its suspension in such a case when compared with the time before its fall if it were thrown up. Next he showed that if the card were cut and its edges curved slightly so that it resembled the screw propeller of a vessel, it would ascend as it flew from a support by which rotatory motion had been imparted to it. This principle, he said, has been applied both in combination with balloons and independently for purposes of ascent and for steering while in the air. A view was shown of the Maxim flying machine, with its

Mr. Frank Butler, of the Aero Club, who, on Nov. 5th, made an exciting balloon trip from the Crystal Palace. Nothing was heard of him until night, when a telegram was received: "Landed Corby, Lincolnshire. Did not see earth for 115 miles."

36 h.p. engine, which is designed to get up a high speed upon rails and then to lift itself in the air and fly; and the opinion of Lord Kelvin was quoted in support of the theory that an aerial machine, with revolving planes, and a parachute at the top to enable descent to be made safely when the propulsive power is exhausted, is practicable. Lilienthal in Germany used these plane surfaces in his flying machine, with which he launched himself from a hilltop upon which he had taken a running start; and in one of his flights he met with the fate which he had himself predicted—he lost his balance owing to encountering a sudden gust of wind, and he fell to the ground and was killed. Mr. Pilcher, of whom the lecturer spoke as a friend, met with his death in this country from a similar cause. The use in America of flying machines with multiple plane surfaces was illustrated, and views were shown to indicate the nature of the latest experiments in a curiously-constructed machine, in which the aeronaut lies face downwards, and having been launched by two men from a hilltop, directs his flight upwards or downwards at will by the movement of a surface extended beyond the machine. A photograph of Professor Langley's machine, which has on board a steam engine driving a screw propeller, and has been tried with success, was among a number of other exhibits. In the course of a brief sketch of the history of ballooning, the lecturer mentioned the ascent of Mr. Glaisher and Mr. Coxwell from Wolverhampton, when a height of seven miles was attained—the greatest from which aerial voyagers have returned safely—and it was explained that this was due to the presence of mind of Mr. Coxwell, who grasped in his teeth the cord opening the valve to permit the escape of gas from the balloon immediately before he lost consciousness in the rarefied atmosphere. Photographs illustrating the flight of M. Santos-Dumont's airship propelled by a spirit engine were also shown. Summing up, the lecturer said the balloon had a certain amount of safety, but was at the mercy of aerial currents, which are enormously greater than anything in the ocean. On the other hand, flying machines, while more able to cope with disturbances in the air, are more dangerous, because, if the slightest hitch occurred with the machinery, they fell to earth like a stone. He dare not say that airships would never come into general use, because the problem of their construction was simply a mechanical one; but the passage of the ocean by large aerial ships looked hopeless when one thought of the difficulty of ensuring that sufficient gas should remain in the balloon until the voyage was ended.

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M. Boulade, in recounting his experiences in balloon photography, says: "We surprise many of our readers in speaking of the dust we meet with in our aerial voyages, far from land and all disturbances. But dust is certainly one of the causes of numberless failures which attend the tyro balloonist-photographer's efforts. This dust forms part of the aerostatic material—it is the ballast!"

* * *

In the presence of the Mayor and Corporation and an immense concourse of people, Mr. Stanley Spencer made an ascent in his airship from Blackpool. At an altitude of about 500ft., the aeronaut made the balloon turn round and face the wind; but the breeze was too strong to permit of his making any progress against it. The airship passed over the sea at the estuary and descended safely after a journey of about twenty-five miles.

# Air Flapping Machines and Personal Flight.

### LECTURE BY MR. J. T. BLANCHARD.

*(Continued from page 182)*

### PERSONAL FLIGHT.

Mr. Blanchard, proceeding to treat of the second branch of the subject—that of personal flight—said he would not detain them by referring to the fabled beginnings of personal flight in ancient Greece. Nor would he refer them to the attempts at personal flight which were made at the end of the eighteenth century in Paris by two foreigners, who publicly exhibited a personal flying apparatus, and who, owing to the primitive nature of the apparatus, came to grief. He would come down to our own day, and would refer to a saying of the modern apostle of aviation, Sir Hiram Maxim himself. (Applause.) From a recent publication he found that Sir Hiram Maxim was reported as having expressed himself in substance as follows: "I do not believe in personal flight. I do not think man will ever become a flying creature. Man, in order to do this, would have to have his nature radically altered, and his bodily frame would have to undergo a sweeping reconstruction. There would have to grow out of his breast bone a kind of ridge or crest, to which there must be attached powerful muscles extending on either side to the shoulders, which muscles would operate the wings. His legs would have to shrivel up into nothingness; his bones would have to be hollow, like those of a bird. Therefore" (said Sir Hiram), "I do not believe in the possibility of personal flight." Now, not being a fanatical believer in the principle of aviation, he took the liberty of joining issue with Sir Hiram Maxim. He (the lecturer) was not a pessimist, such as Sir Hiram appeared to be. In other words, whilst agreeing with his premises, he did not agree with Sir Hiram Maxim's conclusions. It was true that man was not intended by nature to become a flying animal. Man was intended by nature to become a walking, running, perhaps a swimming, climbing, or riding animal, but certainly not a flying animal. But for all that he (the lecturer) said it did not follow that man could not and would not become at no distant date a flying creature. He did not want to be misunderstood. He did not mean to say that man would ever fly with the grace and naturalness of a bird. He did not expect to see the time coming when man, or people of the other sex, would circle gracefully round the spire of St. Paul's Cathedral, billing and cooing with the pigeons—(laughter)—and building nests in those lofty turrets. (More laughter.) He did not expect to see anything of the kind—at least not in his lifetime. He was, however, fully confident that personal flight would be possible, nay, that it would be realisable, at no distant date. All that man had to do was to provide himself with a pair of wings, and learn how to use them. Or, stating the position in different language, he must comply with two requirements. First of all, man must supplement the deficiencies of nature by a practical application of science; and secondly, man must evolve, draw forth, and bring to maturity those innate and inherent powers that nature has implanted in him. That was his position.

### RETROSPECTIVE.

Before taking it up in detail and bringing it home, he would give a brief historical retrospect. There were two pioneers, and two only, in the evolution of personal flight—namely, Lilienthal in Germany, and the late lamented Mr. Pilcher in this country. To these men they paid homage, and admired their pluck, their dauntless courage and devotion to the cause which they had sealed even with their lives; but for all that, and while expressing sorrowful regret at their untimely demise, this fact could not blind them to the imperfections of their apparatus, and their manner of handling it. Two years ago, at the Crystal Palace, an exhibition was held under the auspices of the Aeronautical Society, where the original apparatus used by the late Mr. Pilcher was shown. Some of those present might have seen it, but he personally had not seen it. He had only seen pictorial representations of it, so that in speaking of it he was open to correction; but, so far as he had been able to judge, he distinctly held that he did not look upon the apparatus, either as used by the late Mr. Lilienthal or by Mr. Pilcher, as the best conceivable, or even as a good one.

### A CONTINENTAL INVENTION.

With regard to the apparatus, first of all he objected to it on account of its defective mode of attachment to the person; and secondly, on account of its lack of buoyancy; and he objected to the operators themselves and their methods, on account of their not having put themselves previously through a systematic course of training. Those were the objections he had to make, and he would bring his points home in what he was going to say directly, because he wished now to show them another form of personal flight apparatus which he should likewise criticise, and those criticisms would bring home by implication what he wished to say with regard to the original apparatus of Lilienthal and Pilcher. In looking round the field of aeronautical literature, he had come upon a form of apparatus which struck him greatly, and with which he was at once favourably impressed. He could not help thinking it was far and away better than any of those invented hitherto, and much better than that used by Lilienthal and Pilcher. This apparatus was invented by a continental inventor, whose name he did not feel at liberty to disclose, owing to the fact that he considered the committee of the Aeronautical Institute ought to have the prior claim to it. It was true that a book had been published by this continental inventor, and therefore was public property, yet, so far as he (the lecturer) knew, it might be unknown, either relatively or absolutely, in this country. Therefore he hardly thought he would be acting wisely in disclosing the inventor's name at present, having regard to the fact that this Institute had his first regard; his name having been placed on the roll as an honorary member, he should disclose the author's identity to a private meeting of the committee if they desired it. This inventor had introduced various improvements which showed a considerable step in advance of the apparatus used by Lilienthal and Pilcher, but at the same time, to his mind, it also presented grave defects which he should endeavour to point out and prove, as his humble abilities would permit.

### THE PERSONAL FLIGHT MACHINE.

The apparatus used by this continental inventor was in substance like a huge bat's wings. Drawings of this apparatus (figs. 1 to 17) were now shown; and from these it was clear that the apparatus was intended to be operated chiefly or solely by the upper extremities. The lecturer then entered into a detailed description of the machine, the construction of which will be seen by reference to the figures. He

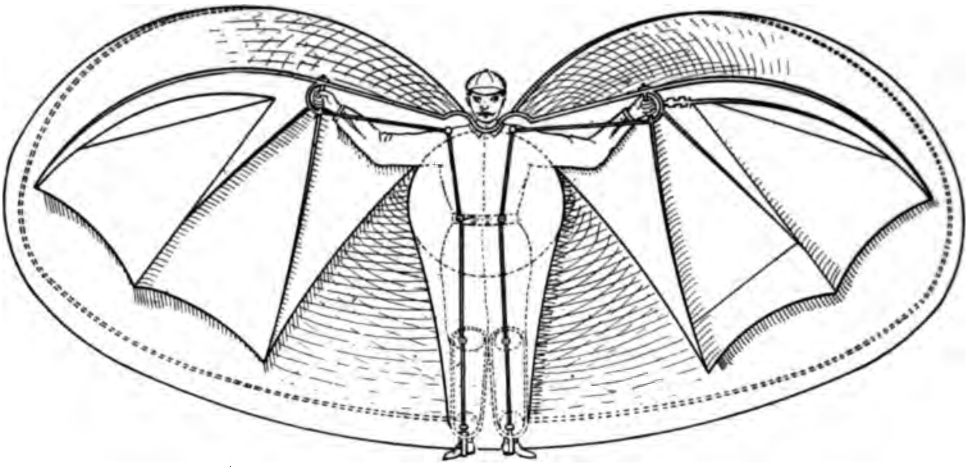

Fig. 1. Front view. Ordinary garment.

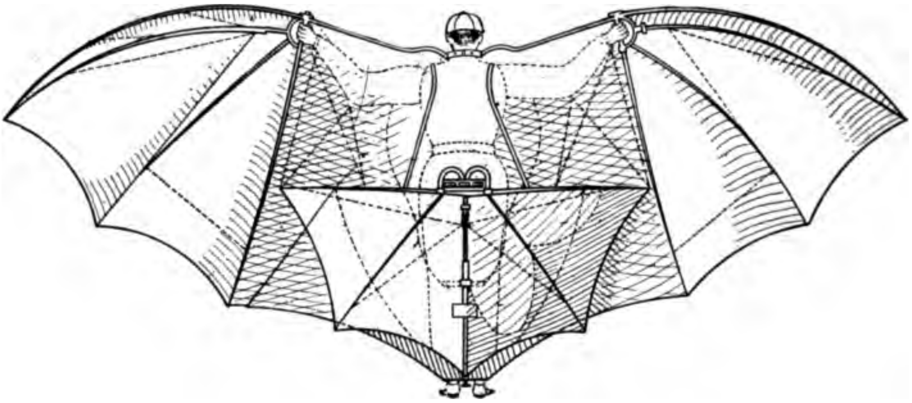

Fig. 2. Rear view. Garment for advanced pupils.

confessed, however, that in describing it he was very much perplexed, for, strange as it might appear, the author in his own book, which comprised over 110 pages of large octavo, did not give a description of the apparatus beyond a few reference letters. He simply gave the diagrams, and the reader was welcome to put any construction he liked upon them. He (the lecturer) was not in a position to tell them precisely what the different parts of the apparatus were intended for, because he did not know; the author had not stated what their functions were, and he (the lecturer) could only surmise what they were intended for. Nor did the author give any idea of the material of which the apparatus was constructed. He (the lecturer) inferred that it was made of flexible material with steel ribs, to keep it in contact with the human body; he only surmised this; he did not know. The author said a great many things which were unnecessary; he said some good and true things, but no description of his apparatus was given. He had invented not only this huge bat's wing, but air cushions which surrounded or encased the upper, and likewise the lower, part of the body, as could be seen from the diagram.

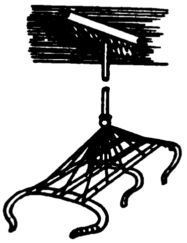

Fig. 3.
Mode of suspension.

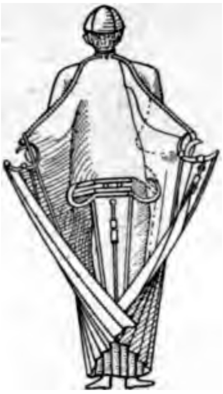

Fig 4.
Rear view with wings folded.

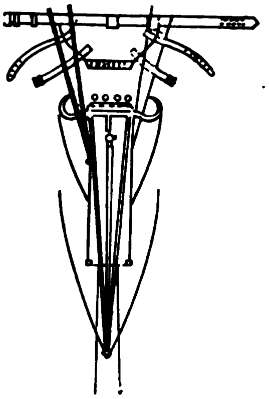

Fig. 5.
Attachments, i.e., straps, struts, and buckles.

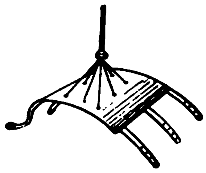

Fig. 6
Breast plate, with straps.

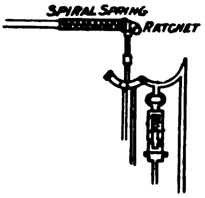

Fig 7.
Steering device.

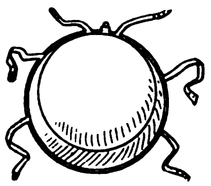

Fig. 8.
Inflation bag for chest, with straps.

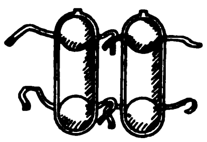

Fig 9.
Inflation bags for extremities, with straps.

The individual operator or flier was thus propped up or buoyed by means of distensible globular bags filled with air. Below the waist there were also other kinds of air cushions, which encircled the legs down to the heels, and others likewise encircled the arms. This was a sensible and judicious idea within certain limits, for it went without saying that the human body, under normal circumstances, weighed many times—about 1,000 times—as much as the amount of air which it displaced. It followed, therefore, if they gave the human body a volume, double, treble, or five or tenfold, its normal bulk, preferably in a globular sense, without increasing its weight, they would cause the volume of air thus displaced to be doubled, trebled, or increased five or tenfold, as the case might be. They would give that body a greater power of displacement, and would increase the resistance which the air offered to it in its free flight downwards through the atmosphere. They therefore checked its downward flight—in other words, retarded the speed with which that body would fall through the air. If they increased the volume of the body by double it

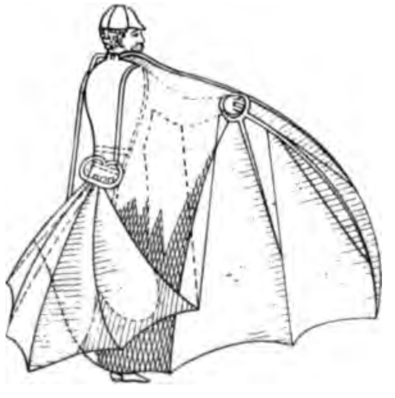

Fig. 10. Side view, with wings partly unfolded.

would fall with half the speed; if they increased it trebly, it would fall at one-third the speed; if five times, it would fall at one-fifth the speed; if it were increased tenfold, it would fall at one-tenth of its normal velocity; and so on. This idea, which had never been denied by any professor of physics, was perfectly sound, and so far this inventor deserved credit. It was impossible, however, to carry that idea to extreme limits, because the human being would be too bulky and unmanageable. There were certain limits to this kind of thing, but the inventor had kept well within wise limits. This apparatus, as shown in the diagram, would measure fifteen feet from tip to tip of the wings. Personally, he considered this somewhat small, and he should only recommend it for youths, and not for stout or heavy people. Such persons would need a flying garment measuring 20ft., 25ft., or even 30ft. from tip to tip. The garment would also have to be attached in a different manner in the case of bulky people. That, in brief, was a general outline of the feature and the disposition of the parts of the apparatus. There was something else which the inventor had introduced, viz., a balloon parachute. It was not exactly clear what he meant by doing this, but the parachute was in the diagram. It had two wing-shaped balloons. Two kinds of apparatus were shown—one for beginners, the other for

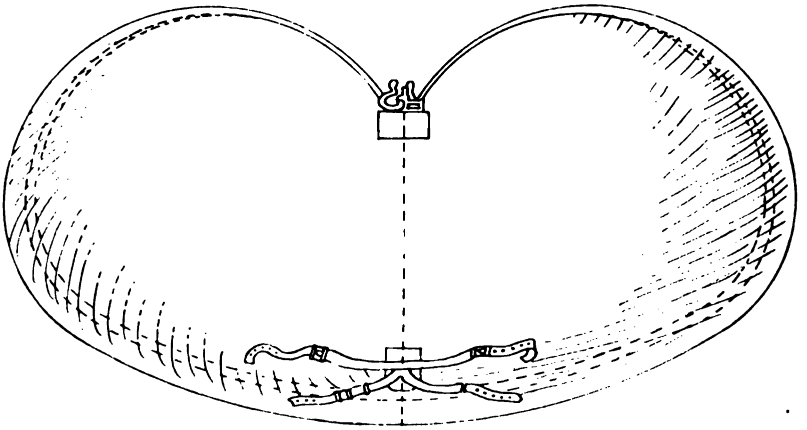

Fig 11. Parachute balloon.

Ratchet for parachute.

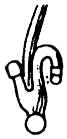

Fig. 12. Side view.

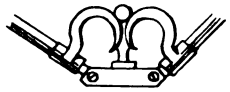

Fig. 13. Horizontal view.

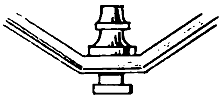

Fig. 14. Valve.

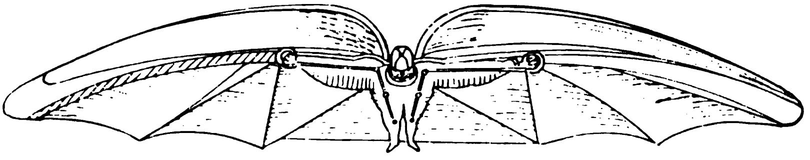

Fig. 15. The flying man, fully equipped.

advanced students. One reached down to the heels, the other did not. Behind the bat's wing which the operator manipulated, there was—so the lecturer understood—a kind of elastic garment, which seemed to adapt itself to the back of the flier, stayed by short stays or struts, so as to leave space between the wing itself and the air shield behind, the air shield being meant to increase the amount of the air resistance. By adding behind the bat's wing proper the amount of that air shield, they had a far greater amount of air surface, which was pressed against by the flier, and which, therefore, tended to support him and keep him floating.

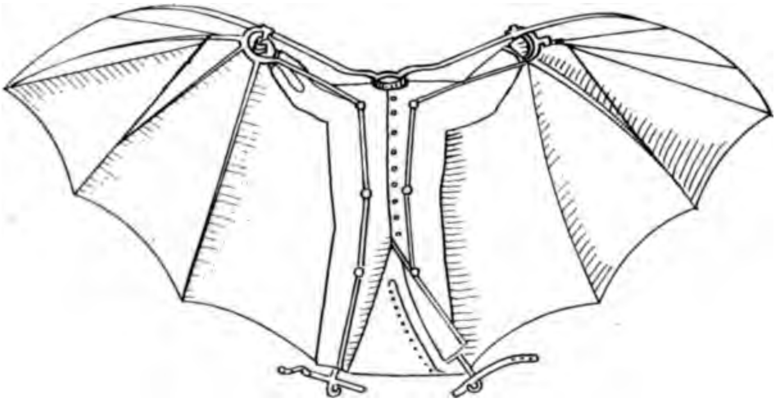

Fig. 16. Flying mantle.

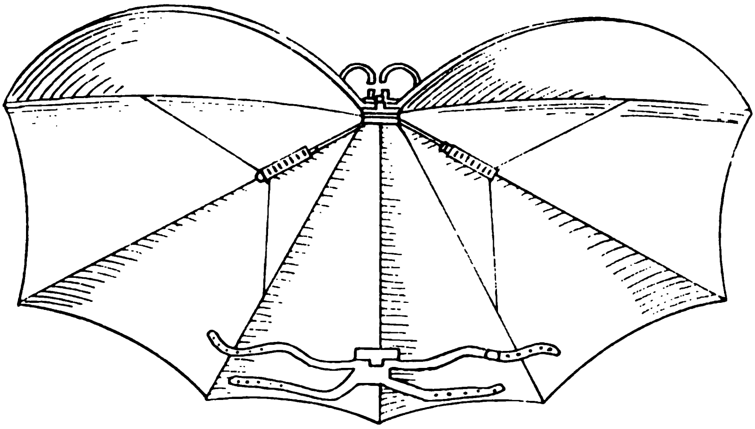

Fig. 17. Parachute for body when in horizontal position

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The Comte de la Vaulx, accompanied by Don Jaimé, son of Don Carlos, and the Comtes de Kergarion and Quiraya, left the Aero Club, Paris, in a balloon, and remained aloft twenty-four hours, finally descending at Nièvre, Central France.

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* * *

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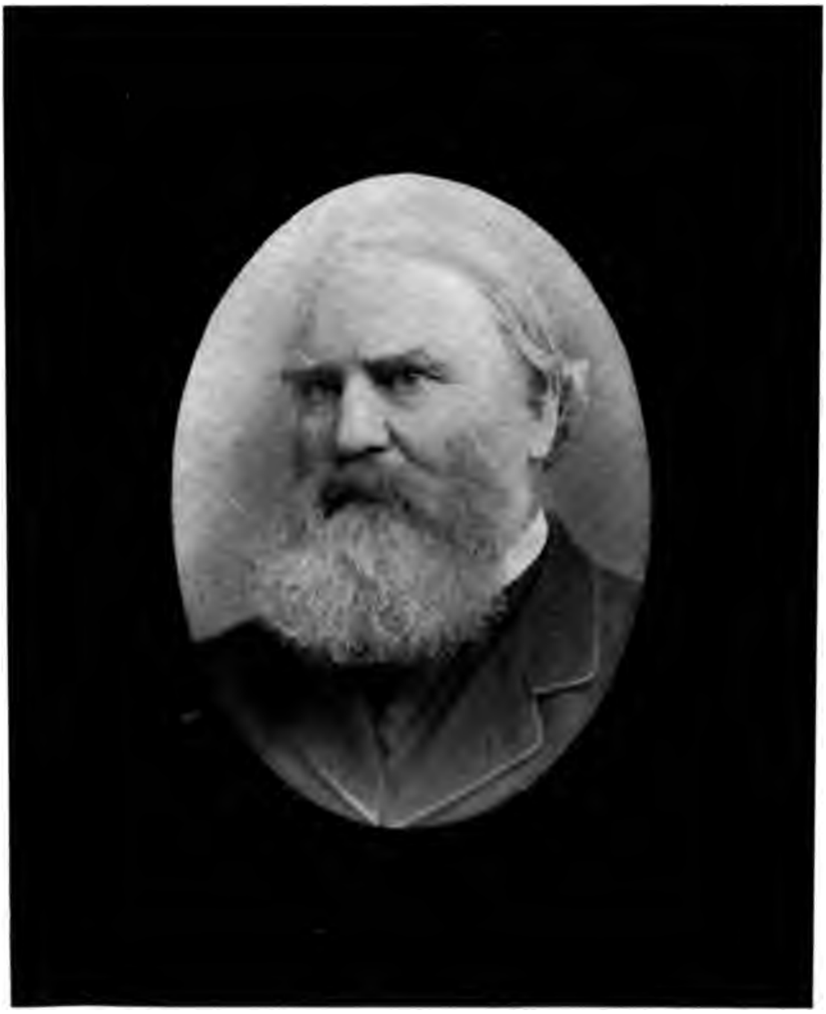

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No. 6. QUARTERLY. APRIL, 1903.

# The Balloon in Modern Warfare.

BY THE REV. JOHN M. BACON, COLDASH, NEWBURY.

## MOCK MANŒUVRES.

A WHOLE generation has passed since a never-to-be-forgotten episode in aeronautics was chronicled, when during a period of extreme emergency a series of ballooning trials were engaged in which were as successful as they were splendid, and which marked an epoch in the history of warfare. From September, 1870, to January of the following year, Paris was closely besieged by the Prussian forces, and every recognised avenue of escape or communication was strongly and jealously guarded. The usual methods of war were under these circumstances resorted to by the besieged, or at least debated. There were the modes then in vogue of long-distance signalling; there was the classical device of floating messages on small rafts or in corked bottles down the river's flood. There was, moreover, the captive balloon, with which to gain information from without, and this was actually taken in hand by chosen aeronauts of ability and experience, viz., MM. Godard and Yon.

Under the direction of these experts there were regularly appointed captive ascents made daily in fair weather, by night as well as day, the object being to watch the movements of the enemy, and to locate their positions. These experiments were carried out with due method and no lack of skill, but from a strategic point of view they were practically abortive.

It was then that other measures failing a new departure were entered upon in the form of the free balloon, and, fairly looked at, this must be regarded as having proved a highly satisfactory instrument of warfare. During four months of the siege some sixty balloons were despatched from Paris, fully equipped, conveying altogether some two millions and a half of letters, as well as other freight, while no less than two hundred actual passengers were transported from the city, of whom only about twenty in all met with serious mishap.

Surely few more brilliant or successful enterprises of a special kind have been recorded of any campaign. And yet in thirty years these grand experiments seem to have dropped out of memory, and even the peculiar exigencies of the late war in South Africa failed to revive them. The captive reconnoitring balloon was, indeed, used at great cost, though with what aggregate success it is at any rate outside the present paper to discuss. But what of the free balloon? Kimberley and Ladysmith were under siege, and in default of the heliograph would have lacked all important intelligence. Mafeking, however, was entirely cut off from outside communication for a long and most critical period, and yet the free balloon was at hand, as were also all known modes of signalling over long distances from the sky.

It occurred then to the writer at this time to institute some properly organised experiments which should put to the test whether the free balloon was capable of being utilised to somewhat the same extent as in the Franco-Prussian war under the altered conditions of the present day, and in this endeavour, meeting with the readiest and most generous co-operation of the military authorities at Woolwich, a balloon ascent was arranged to take place in front of the Royal Artillery Barracks, which, having regard to prevailing weather conditions, suggested the following test case as one worthy of trial. Woolwich must for the nonce be considered closely invested by a watchful enemy, while it was required that an aeronaut within the town should attempt to escape by sky, bearing off supposed despatches without incurring the risk of being disabled by the enemy's fire. For this endeavour it chanced that the weather conditions, which made other observational or signalling work impossible, rendered all things easy. The lower air was perfectly clear over a long range of vision, but the sky overhead was densely overcast at an altitude of only a few hundred feet. Thus the balloon preparations could be proceeded with without hindrance, and the direction of its course could be well scrutinised. Moreover, being shielded by lofty buildings, the inflation could be carried out, so far as

THE ASCENT AT WOOLWICH.

the supposed experiment was concerned, with complete safety, and so soon as this had been duly accomplished the actual departure, as will be seen, might be contemplated with perfect complacency by the escaping party.

Woolwich Common is proverbially a wind-swept plateau, and even on a moderately calm day angry and sudden gusts were apt to spring up and try conclusions with the swelling globe. But there were able and ample help in the voluntary services of a party of the Royal Engineers, unlimited as to number, who were freely placed at our command. The training of such men renders them the most capable aid in carrying out any manœuvre requiring that all should act together and act promntly. Thus Mr. Percival Spencer, who had provided a balloon of 45,000 cubic feet capacity, admirably suited for our purpose, and who now took it in charge, found no difficulty in so paying out ballast, and at the same time keeping the men holding well together, that the balloon should be "lifting" strongly, and yet ready to be liberated instantly as by one man at a simple word of command. In this way, carefully watching the gusts, and seizing the psychological moment, it came about that we broke away, smartly shooting up and burying ourselves in the mist canopy before two photographers in the car were able so much as to take a snap shot of the ground we had left. Clearly, no enemy, however vigilant, would have had a chance to have taken so much as a flying shot at us, and so far the escaping party, carrying all they desired, might claim to have got clean away.

The rest of the enterprise was left to chance developments, and it may be at once stated that it suited the humour of the aeronauts on this occasion to stand by whatever fortune a prolonged flight above the clouds might bring. The writer was accompanied by his son and daughter, both as ardent votaries of the balloon as himself, and making up a complete family party.

A DESCENT IN THE MIDLANDS.

The Rev. John M. Bacon (with the beard) is standing in the car.

Thus there was the feeling that none need be anxious on the score of others left behind, and as for the writer's old colleague, Mr. Spencer, he has always maintained that descending from a family of aeronauts, all of whom have died in their beds, a balloon is the safest place for him—so long as he has control of it.

An hour had slipped by, and we had known little of earth, save that it must be gliding by beneath the cloud at from 3,000 feet to twice that distance below us. The din of Woolwich Dockyard had come up, muffled by the fog, and soon died away. The big bell of the Parish Church, which at my request, and for a certain sound test, had been set ringing for half an hour, had never once been heard, and the piercing ping of the rifles on the many ranges, as also the booming gun practice on Plumstead Marshes, had now faded out. There was that dead silence known only in balloon travel which convinced us that we were sailing over open country.

At this period then there seemed excuse, remembering the main object of our voyage, to dip down through the mist and reconnoitre our surroundings. So with frugal expenditure of gas we climbed down through the dank lower cloud wreaths, and, gathering a burden of dew on our silk, dropped out in the clear, when, topping a tall elm, we slid down in such a paddock as might belong to any of the home counties. Indeed, friendly countrymen clustering round us told us we were within a mile of Hertford, and urged us to alight. But the game was not yet played out. True as in days of besieged Paris, the balloon had fairly escaped to the open country, where were only people of the soil and well wishers, but to play the strict rules we must suppose that the neighbouring town, only thirty miles from Woolwich, was in occupation of the enemy, and that we were not yet beyond their reach.

A BIRD'S EYE VIEW OF THE GROUND TRAVERSED.

So we determined to reascend, and here were met by our first difficulty. The end of the trail rope had whipped itself into a knot high up in the elm, and refused to be coaxed down. Moreover, so heavy was the balloon with moisture that it declined to rise again, even at the cost of all our

THE STARTING PLACE, FULHAM.

ballast. Thus baulked, we resolved on the heroic measure of dropping our heavy trail rope altogether, and as a result our balloon now mounted in earnest, and, rising well into the hot sunshine, gained such great ascending power that we were soon three miles above the earth, which was entirely hidden by the dense cloud floor far down.

Of course, the right manœuvre now was to let the balloon settle of its own accord, and thus allow it to form a natural parachute to abide the final issue. And this issue came abruptly ere another two hours had passed. Much gas had escaped in reaching the upper limits, and when the downward course began there was the long drop with a lightened balloon, and no check save that which the hollowed silk above afforded. Average good fortune being with us, however, there would be little

A DETACHMENT OF THE 26th MIDDLESEX CYCLISTS' CORPS
who took part in the race. The Rev. John M. Bacon can be easily distinguished in the centre of the group.

CAPTURED.

cause for anxiety with such a balloon as we occupied, and which Mr. Spencer had arranged to meet any such emergency as the present, and it was simply a question as to where the alighting would take place—a matter which, of course, was alike beyond our control, and beyond our guessing also, by reason of the cloud that hid all the earth. The entire long drop was not long in duration, and when near earth we could only judge from the silence that still reigned that we were once again about to land in open country.

And so it proved. Green fields suddenly loomed large below us, and after an interval reckoned roughly as five seconds we plunged into a typical moist Midland pasture. We were now a hundred miles from our starting place, far from any towns, and only one man had seen us fall. Thus we might legitimately claim that our mock escape was complete, and the game fairly won.

The "return match" was contested later in clear weather on a summer's afternoon, the air being, in fact, too still to give the escaping party a good chance. It was arranged on this occasion that the balloon should be actually pursued from the start, and, save for the first half-dozen miles, when the pursuers—trained military cyclists—were at a disadvantage through a broken ground, the race was dead against the aeronauts.

The start was from Fulham, and after thirty miles the cyclists, never far behind, were practically overhauling us. The only manœuvre left us was to drop in awkward

IN AT THE DEATH.

country, and this we found behind a private park, where rising ground and "no thoroughfare" would baffle the riders for a while. Alighting quickly, I hid in a shock of corn, vainly hoping to avoid detection. But it was not to be, and in ten minutes this second contest was won by a small party of the "enemy," who had thus pursued a most game race with splendid pluck and perseverance.

Following up the same line of experiment, I am arranging for a further, and I trust most interesting, trial, which I shall embark on shortly. In the siege of Paris an attempt was made, but without success, to enter the beleaguered city from without. I am now making preparations, as soon as a suitable season arrives, to attempt this far more difficult strategic feat under crucial conditions.

# Motor Aviation of To-day and of Recent Years.

## By SIDNEY H. HOLLANDS.

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ASPIRATION.

"3. That the mean pressure on the concave surface is higher than on the convex side.

"4. That the chord of the curved metal plate may make a negative angle of ten degrees with the direction of the wind, and still have a higher pressure on the concave side than on the convex.

"The direct inference is that gravity can be entirely counteracted by a volume of disturbed air moving in a horizontal direction, and that flying machines of great weight can be held suspended in a horizontal wind, and rise vertically without the expenditure of any contained motor force."

Having put matters so that anyone can easily repeat my experiments and elaborate them to the last degree of precision, we now see why the best soaring is done in steady winds. The answer is, the bird is less liable to lose its vortices by a sudden gust, and have to take a flap or two to balance itself on a fresh pair.

The difference between *flying* and *soaring* is that the air in contact with the underside of the wing is moving towards the bird's head when soaring, and towards the tail when flying. "A soaring bird's wing is a shield dividing two currents of air moving in contrary directions."

The vortex draws towards the shield, and pushes it into the low pressure above the wing.

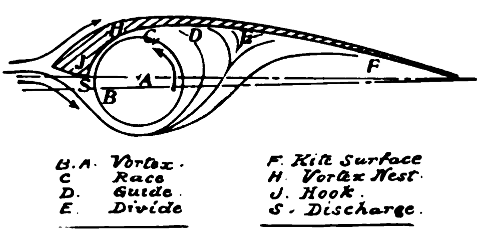
Mr. Hargrave says further in another paper (November, 1898) entitled "Soaring Machines":

"I have noticed that soaring is easier in a wind velocity that is increasing than when it is decreasing, and attribute this to volumes of air of high density and velocity driving in under volumes of lower density and velocity: the contiguous surfaces will then cause eddies in the combined mass rotating in the same direction that the soaring vortex does—that is, the upper part of the eddy moving to windward and the lower part to leeward, one of these would be more readily caught and held by the propeller than when the contrary conditions prevail."

Mr. Hargrave then states these further instructive conclusions with illustration, fig. 17:

"This illustration shows the condition of the air in the neighbourhood of the soaring curve, and the following statements may help us to arrive at the exact power developed:

Fig. 17.



"1. The hook J originates the vortex.

"2. The diameter of the vortex is determined by the radius of the race.

"3. The velocity of rotation is something less than the velocity of the wind or relative wind, and is maintained thereby.

"4. The air drawn in from the rear of the vortex rises in pressure as the race contracts.

"5. The high pressure air in the race acts on the soaring machine by thrust on the vortex nest.

"6. The vortex cannot increase in diameter or burst, because the vacuum at the centre is of the exact tenuity that balances the centrifugal force of the particles of air forming the vortex.

"7. If the head resistance of the soaring machine is decreased by a lull in the wind, the air in the race expands, leaving the vortex slightly to leeward, that is, practically increasing the radius of the vortex next, the vortex then increases in diameter and rotates slower, draws in less air past the guide, and restores the equilibrium.

"8. Some of the discharge from the race may pass into the dead air to windward of the hook, and so over the top of the soaring curve, or, if the dead air space is filled up solid with part of the material of the soaring curve, the whole discharge is carried under the vortex, and may or may not be drawn in again between the vortex and the guide. The discharge cannot mingle with the air of the vortex, as every circumferential particle of its air is held at a fixed distance from the centre by the tenuity of the vacuum.

"9. The lower front quadrant does not add to the head resistance, as it is rotating to leeward nearly as fast as the relative wind.

"10. The after part of the soaring curve, if it extends to leeward of the divide, acts as an aerocurve. . . .

"When the wing (of a soaring bird) is rigidly extended, and the soaring part lifting properly, the tip, when in the plane of the true wind, will have the relative wind acting on its upper surface, and be in effect a kite wrong side up.

"The position of the tip, that is, whether it incline up or droop when viewed from front or rear, is a clear indication of whether the bird is soaring in a horizontal or a downward blowing wind, or merely being supported by an upward trend of wind.

"The albatross and frigate bird show the drooping tip to perfection. Hawks and eagles frequently show the upward bent tip, and when they do so we may safely conclude that any flat object would be upborne by the wind in their neighbourhood. Birds that circle in calm or nearly calm air have the wing tips turned up, and, if the performance takes place over a hot and dusty plain, the conditions are favourable for the formation of a sand column or 'whirley.' The bird that soars in a gale has a deeper concavity of wing than the one that soars in a moderate breeze, from which I deduce that the velocity of rotation of the vortex must have some point of maximum efficiency. In other words, the small vortex cannot attain an infinite velocity, and the large vortex loses its efficiency when its speed of revolution is reduced below a certain point.

"Each form of soaring wing is evolved by the average velocity of wind in the latitudes frequented by the bird. . . . A further consideration of the horizontal projection of a soaring bird's wing shows that the tip or flat part is approximately half the area of the soaring part."

It is a very interesting fact that Mr. Hargrave has demonstrated the practicability of applying the "aspirating" principle to the propulsion of aquatic vessels in his very ingeniously designed "wave-propelled vessel," in which no motor, in the ordinary sense, is carried. The aspirating appliance or propeller in this case is not aerial, but submerged, and acts on the water. This application is of interest as constituting a curious analogy, where the two fluids in question—air and water—are so widely different in most respects.

Yet, after all, to utilise wave-power, as aquatic aspiration does, is to use wind power indirectly, seeing that the winds give rise to the waves, though it be at a distance.

The phenomenon aerial aspiration has only been discovered, or one should perhaps rather say, understood and intelligently studied (seeing that the birds have practised it to good purpose ever since their advent on earth), in quite recent times.

The late Mr. Frederick W. Brearey, honorary secretary of the Aeronautical Society, appears to have been the first experimenter to investigate it at all, and this was as recently as 1875-1880. In the year 1879 he even made practical use of it. Having suggested to Captain (now Colonel) Templer, head of the army balloon department, that a small aspirating machine which he (Mr. Brearey) was prepared to design might be usefully employed as a means of transmitting written messages, sketches, etc., from a balloon used in military reconnaissance back to its place of departure, and, therefore, *against the wind.* Mr. Brearey designed and made such apparatus, and the experiment was made. The little motorless "aspirator" was released from a balloon at a considerable height, and in a stiff breeze, by Captain Templer, when it quite successfully travelled back against the breeze to very near the point of departure of the balloon. Thus was demonstrated a practicable means of communication in warfare, and one capable of important development.

It is not generally realised that air has the property of inertia, and yet that valuable property enters largely into the phenomenon of flight, including aspiration, and is the reason why high speed is so conducive to successful flight.

In conclusion, it may be pretty confidently asserted that, if we are destined to ever accomplish aviation with very little, or even *no, self-contained power*, and thus emulate the admirable examples and proofs of the possibility of this ideal flight that we see in nature, we certainly shall have to invoke aspiration's artful aid.

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A series of experiments have been conducted at the artillery ranges at Steinfeld to ascertain the chances of a balloon in mid-air being hit by ordinary artillery. A captive balloon was sent up as a target for four guns, the officers in charge having to judge for themselves its height and distance away. Twenty-two rounds were fired, and it was found that the altitude had been under-estimated greatly. It was not till the sixty-fourth attempt that the silk was pierced, and the balloon brought to the ground.

# The late Fredk. W. Brearey, B.Sc., etc.

*See Frontispiece.*

FREDERICK WILLIAM BREAREY, "the father of the modern school of aviation," as he has been well styled, was born in 1816 at Stillingfleet, near Scarborough, Yorks, of an old Yorkshire family.

Young Brearey evinced an early leaning towards aeronautical pursuits. This taste was thought to have been fostered, if not originally inspired, by the fact of Sir Charles Cayley, author of one of the earliest works on "aerial navigation," having been an associate and friend of the boy's paternal grandfather, then Lord of the Manor of Middlethorpe, where the bright youngster was a frequent and interested visitor.

As adolescence succeeded boyhood, young Brearey's aerial dreams and predilections began to take intelligible shape, and started on a course of development along legitimate lines. From the first he seems to have almost instinctively realised the fact—the most important fact—that buoyancy or ballooning projects and true flight have nothing in common.

It was not until the year 1866 that he made any considerable progress, but in January, 1867, "The Aeronautical Society of Great Britain" was founded in London, at the house of the late Duke of Argyll, Campden Hill, under his distinguished patronage and presidency.

The fact of a nobleman of such acknowledged and well-known scientific eminence becoming president of this society considerably abated the ridicule of Mr. Brearev's acquaintances—unhappily, ridicule of the subject, born of ignorant prejudice, was at that time only too generally prevalent, but for a considerable time thereafter the failures of the aeronautical projects of others were visited upon him more or less. The injustice of this course will be gathered from the following memorable remarks made by Mr. Brearey, as honorary secretary of the society, in December, 1888: "I was always averse to raising the hopes of the public by the issue of premature expectations. By maintaining this attitude I believe we have retained the respect of the public, and the continued support of the few members who enable us to keep up our organisation, and enable me as its secretary to hold communication with correspondents in all quarters of the earth. . . . It is useless continually meeting to talk and read papers which appear to have no effect in advancing the science. I very early realised this as tending to encourage the expression of outrageous views, in connection with which the council of my society had no sympathy, and yet would be compelled to admit in order to fill up an evening. . . . I felt, however, knowing full well the tendency of enthusiasts and fanatics to air their crotchets, that the society which I represent might become ridiculous as a scientific society in connection with aeronautics if frequent meetings were held, and set my face against it."

When it became known abroad that the society was formed in Great Britain, plans and suggestions from all parts of the civilised world reached Mr. Brearey, together with applications for the money whicn it was supposed that John Bull was anxious to lavish upon inventors, and from that time onwards, nearly thirty years, the copies of letters all in the handwriting of Mr. Brearey, together with the numerous letters received, testify to the gratuitous labours of the honorary secretary.

The Société Française de Navigation

Aérienne soon voted him their gold medal, and as showing the effect which his papers read at the meetings held at the Society of Arts, and his contributions to the current literature of the day (for the most part reprinted in various other countries), had upon scientific minds, one of several letters spontaneously addressed to him will suffice.

It was from the president of the "American Society of Civil Engineers," Mr. Octave Chanute, dated from New York, February 3rd, 1882: "We are in this country aware of your long-continued experiments and efforts to promote a solution of the problem of aerial navigation, and know that it is through your influence that the subject has been cleared of much rubbish, and placed upon a scientific and firm basis."

As before intimated, Mr. Brearey early acquired the conviction that dirigible and safe aerial navigation could never be accomplished by balloons, however useful they might be in their own restricted sphere, so that all his attention and experiments were directed to the mechanical means of attaining it. These were so suggestive and encouraging that in a lecture hall he was able to show various forms of sustained flight over the heads of the audience, and, although he lectured in more than fifty cities and towns in England and Scotland, and liberated model aviators up to about three pounds weight, with a spread of wing of 12ft. 6in., he never caused an accident which created anything but kindly amusement. The behaviour of these models was sometimes startling. At Plymouth, for instance, one wing-flapped bird-machine flew twice round the hall and returned to Mr. Brearey's hand on the platform, as if directed. At Truro, in a very large hall, a screw-propelled plane flew to the end of the hall, and, without touching the wall, veered round and returned to the platform, and got hung up on one of the gas fittings there. At the Hartley Institute, Southampton, he liberated from his hand the model of an albatross, with wings of 12½ft. stretch, made of very slender and flimsy material, both as to framing of wings and the covering fabric, so slender, indeed, that in holding it out ready for flight, the wings dropped on each side of him, so that no one would have thought flight to be possible with it, but the moment that the stored power came into operation and motion was imparted to those drooping wings, they stiffened out, and through the reflex action at the tip of the wing, which effects propulsion, the model flew the whole length of the hall, at about two feet above the heads of the audience, and, although rising towards the end of its flight, just cleared the gallery. This was repeated with a like result in response to continued applause. Mr. Brearey introduced and applied in his winged and "wave-action" types of aviator a very ingenious appliance which alone rendered possible their successful flight, in view of the strictly limited self-contained power that could be applied to them. This is an accessory analogous to the very potent pectoral muscles of birds of flight, and called by him the "pectoral cord." It consists of an elastic cord, the ends of which are fastened to the underside of the wing frames, or the "wave arms," and the middle of which passes under and takes an abutment against a central forked strut, which latter is an equivalent for the "keel" or extended breastbone of birds, to which their pectoral muscles are anchored.

This admirable appliance, as in natural flight, is the medium by which gravity is enlisted as an *extraneous* source of power, in that it is maintained in a state of *tension* normally throughout flight *by the weight of the bird, or the machine,* which thus becomes a source of power, and may be called an auxiliary gravity motor.

We now know that in the case of the albatross notably, this is the *principal* source of its power.

As demonstrating the importance and efficiency of this aid to model flight, Mr. Brearey would wind up the motor—consisting of stout indiarubber strands in torsion—say thirty-two turns, and show that this store of energy alone, although sufficient to flap the wings vigorously whilst the model was held in the hand, was inadequate for flight, as, when committed to the air, the wings would at once be thrown to their highest position, and remain there inactive. He would then unwind the motor, and rewind it thirty-two turns, but this time connecting up the "pectoral cord." Holding the model in his hand again, he called attention to the fact that the wings were then stationary, that it was powerless to flap them, because the two forces were opposed to each other. It demanded the co-operation of other power (the auxiliary force gravity) to effect flight. The model was then launched from his hand, its gravity came into play, flexing the "pectoral cord," thus making it *a reservoir of energy*, the wings flapped vigorously, and free flight was straightway accomplished.

Mr. Brearey was equally successful with screw-propelled planes, and it is on record that he suggested to Captain (now Colonel) Templer, R.E., the means of sending information to a distance from an army balloon. Mr. Brearey having supplied the apparatus, which was of simple construction, Captain Templer liberated it from a balloon at a considerable height—having started from Woolwich Arsenal—when the little motorless "aspirator" successfully travelled back to the Arsenal *against the wind*. Thus a dead weight was translated aerially in a desired direction, and a valuable means was demonstrated of sending back news, sketches, etc., to the starting place of a balloon in military reconnaissance. This successful experiment was recorded in the *Daily Telegraph* of 10th October, 1879, and in other London newspapers.

As a sample of the brilliant suggestions that have been made to Mr. Brearey by correspondents from time to time, the following is a fair specimen: It was seriously suggested that the propulsion of balloons might be effected by surrounding the gas vessel with compartments in which hawks could be placed and tethered to the balloon. When the aeronaut desired the balloon to go ahead, he had only to shout at the hawks, and the birds, being thus frightened, would, of course, straightway forge ahead with the balloon.

This original genius even held that the hawks could be trained to pull all together, and so hawk the balloon about the country.

Upon two occasions Mr. Brearey suffered physically in the cause he espoused so well.

At the Aeronautical Exhibition, held at the Alexandra Palace in 1885, when conducting some experiments with aerial screws, one whirling at high velocity threw one of its blades off, striking him in the face, inflicting a severe wound, and narrowly missing an eye. On another occasion, when returning from the Crystal Palace, where he had for several days been attending some interesting experiments in aeroplane propulsion, a railway accident occurred to his train, resulting in concussion of the brain, which laid him up for many weeks.

The writer of this brief memoir for about fourteen years enjoyed the friendship and confidence of the late Mr. Brearey, while a member of the Aeronautical Society under his able secretaryship, and had from him at first hand the bulk of the matter contained herein, as a mass of cherished correspondence will testify.

It was somewhat of a trouble to Mr. Brearey that there was not then in existence a light powerful motor of suitable type and duration of power for actuating his "wave-action" type of aviator on a large practicable scale.

As he had often discussed this matter, the outcome of it was that the writer undertook to design for him a light direct-acting non-rotative steam motor, adapted for his type of machine (and illustrated in one of my series of articles herein), but, unhappily, before there was time to get a large one constructed, his lamented decease took place at his residence at Blackheath.

On 31st January, 1896, Frederick William Brearey suddenly but peacefully passed away at an advanced age, having for almost a lifetime strenuously and consistently promoted the cause he had so much at heart. His loss was keenly felt by all those in sympathy with aeronautical progress, as well as by his numerous personal friends.

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Six balloons—one of a capacity of 37,000 feet—and three parachutes, sold under an execution from the Clerkenwell County Court, realised only £35.

* * *

Mr. Stanley Spencer is visiting various towns throughout the country and exhibiting the airship upon which he has made his successful trips. The exhibitions have aroused considerable interest.

* * *

The death has occurred in Dublin of Mr. John Hodsman, who was one of the first balloonists to cross the Irish Sea, a feat which he accomplished on April 22nd, 1867. For fifty years he has been a firework manufacturer.

* * *

*The Autocar*, the paper devoted to automobilism, has announced that it will have a captive balloon floating over the course of the international motor race for the Gordon-Bennett cup to aid in reporting the great event. The balloon will be used as an aerial observing and signal station. Messrs. Spencer are constructing a special balloon for the great event, which will be christened "The Autocar."

The balloon St. Louis, with which an attempt was made to break the record for the longest aerial journey, came to the ground in Slavonia after being only thirty hours in the air. The record is 41h. 5m.

* * *

French aeronauts are seriously proposing the use of captive balloons as astronomical observatories, and they have plausible reasons to urge in behalf of this plan, chief among which is the possibility of getting above the clouds and so securing continuity of observation for long periods, which in certain cases is of great importance. In *La Science Illustrée* M. W. De Fonvielle states that it is proposed to make nocturnal ascensions in the nights near full moon to study the firmament in a clear sky, either with the unaided eye, or better with the aid of field-glasses of considerable power. As the number of radiants already known and catalogued reaches several hundred, they may then, proceeding at random but in a perfectly clear sky, discover phenomena—such as the appearance of remarkable meteors, temporary stars, comets, etc.—that would escape astronomers who remain on the earth's surface.

# Light Motors for Aerial Navigation.

By Sidney Russell.

FROM the date of the earliest experiments in the field of aerial navigation, the question of a light and suitable motor has been a very serious one, and, without doubt, has many times proved the weak spot in many a promising device.

The simplest of the many devices is without question a strong spring, and this has been repeatedly employed in experimental models, of which the following are two very good examples. The first is explained in an extract from an interesting paper read before the Aeronautical Society, June 30th, 1873, and entitled "The Aeroplane," by Mr. D. S. Brown [which, in passing, it is most important to note corroborates Mr. Sidney Holland's exhaustive article in several instances (see *Flying* No. 1)]. This paper appears in *The English Mechanic* for July 18th, 1873, and on page 447, vol. xvii. After describing his experiments with models employing screw propellers, he says: ". . . Lightly as it may be regarded, it is by this that the most striking results have as yet been obtained in mechanical flying. I find by experiment that about 15 lbs. of indiarubber cord stretched to seven times its length will, in returning to its normal state, yield a power equal to one horse for a minute. It should be placed in the tubular framework of the aeroplane, for it is dangerous to handle when so stretched. . . The objection to spring power is its short duration, but a confined fluid may be made to act as a spring by alternately heating and cooling it, and the force would be thus rendered continuous."

On page 657 of the same volume is a drawing of a very successful model driven by elastic springs. Fig. 1 is a copy of this, the description following also being from the same source: "A is a plane measuring 28in. × 4in., the frame of which is very lightly constructed and the membrane of tissue paper; *b* is another smaller plane separated at about 15in. from the former by the rod C to give stability by acting as a tail. In front is the screw-propeller *d*, 5in. diameter, the blades being flat and set at an angle of 45°. They can be formed of thin scaleboard or veneer wood, and inserted into a small cork to form the axle, into which axle is also inserted the end of the spindle *e*, made of a very slight knitting needle. The part inserted in the cork should have some thread wound round it and glued to prevent it slipping. The spindle has its bearings on each side of the frame, and the other end terminates in the knob or handle *f*; *g g* are two small pieces of indiarubber fixed to the extreme ends of the frame and joined to the threads *h h*, which latter are also fastened at their other ends to the spindle.

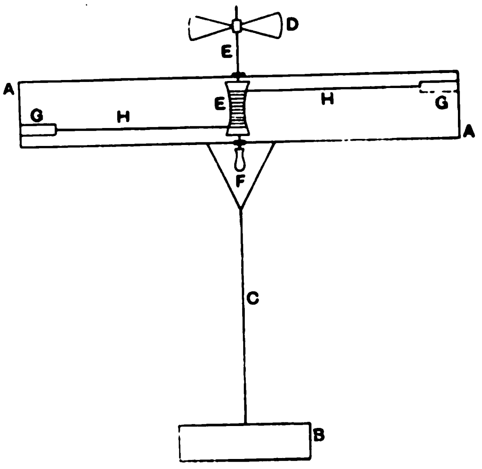


Fig. 1. D. S. Brown's aeroplane (1873).

To prepare the machine for action the spindle is turned, by means of which the threads are wound round it, and the india-rubber stretched to about six times its length. The re-action gives a rapid revolution to the propeller, which, so long as it continues, draws the aeroplane along in a horizontal direction."

Mr. Brown then alludes to another model by a Mr. Martin, in which the power is given by elastic, the indiarubber, however, being twisted instead of stretched. This was carried out in a curious little French toy called a "mechanical bat," of which fig. 2 is a sketch from the *Scientific American* for January 20th, 1877, page 38, vol. xxxvi., and from which I quote the following brief description: "A, B, and C are semi-circular pieces of cork. Between A and B are secured two thin wooden rods D made of orange or of some other light strong wood. From A extend arms, between which and the adjacent rods D are pasted tissue paper wings. In A is rigidly secured a hook; a similar hook in B turns freely therein, but is fastened in the other piece of cork C. Between the rods and from hook to hook is stretched a rubber band E, and in the cork C are inserted two feathers like the fans of a propeller. The apparatus is wound up by turning the cork C until a strong twist is thrown in the rubber E."

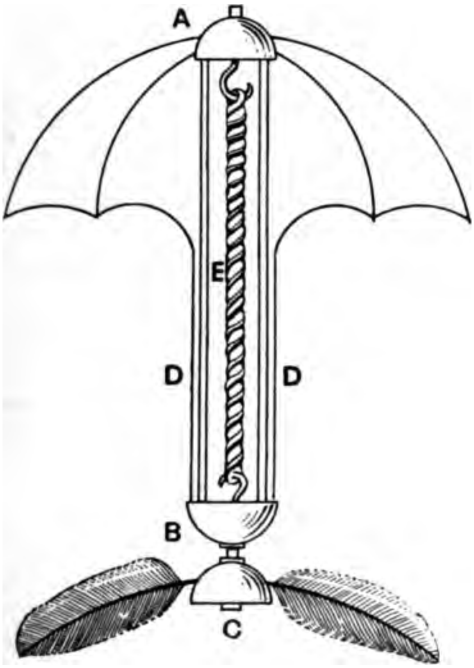


Fig. 2. French mechanical bat.

The writer well remembers as a boy seeing one of these toys in operation, and, considering the very flimsy manner in which it was constructed, it was remarkable what very fair results it gave.

These experimental models, trivial though they may appear, yet will not be deemed out of place, as they serve to illustrate the fact that much may be done with a spring motor, even though it be of very rudimentary character.

Another motor of the same type is a clock spring, this being often employed, and though superior to the indiarubber arrangement, yet leaves much to be desired. Mr. Rufus Porter, of America, whose experiments with cigar-shaped balloons date back to 1820 (and whom the writer believes to be the first one to employ practically the hollow square rudder), obtained some very good results with model balloons propelled by these means. Of course, short flights only are possible, and with the continued improvement in every branch of mechanical arts, it is not surprising that the spring motor has been abandoned, to a great extent, in favour of the steam engine. A long and interesting account of Mr. Porter's experiments, together with his dimensions for a steam aerial vessel or navigable balloon 400ft. long, will be found in the *Scientific American* for November 27th, 1869, vol. xxi. He proposed to construct the engines, which were to develop 100 h.p., principally of brass, while the boiler was to be of the water-tube type, and was to consist of a series of vertical copper tubes 2in. in diameter, connected to horizontal pipes 1½in. in diameter above and below, forming steam and water drums respectively. The whole arrangement is most interesting, the weight for a balloon of the size stated being said to be 500 lbs. No drawings are, however, given, and space will not admit of the full description being here inserted.

It is not intended, and, indeed, it is not possible in the limits of this brief article, to embody a history of all the various schemes for obtaining motive power for the purpose of aerial flight. It is rather the object of the author to set forth, so far as possible, what has been done in recent years, or, perhaps, more especially within the limits of the past century. Naturally, this necessitates a selection from a very large variety, but it is hoped that this will be a fairly representative one, and perhaps afford some hints for future practice. In relation, therefore, to Mr. Porter's experiments, it is interesting to note that no sooner was the high-pressure engine a proved success than the idea occurred to several thinking minds that a light form of engine and boiler might be employed for this purpose, and it is further of great interest to find that the boiler in the early example about to be described was very similar to that so successfully employed by Professor Langley, that is, a coil of tube, being, in fact, a semi-flash water tube boiler.

This clever attempt took place in the United States, and was no doubt the result of an intelligent study of Oliver Evans's excellent work in the perfecting of the high-pressure engine in America. The following description is condensed from the *Mechanics' Magazine*, vol. iii., page 50, dated October 16th, 1824, and is headed "The American Capillary Steam Engine." The inventor, Mr. Joseph Buchanan, after detailing his experiments with a small engine, proceeds as follows: "We then made arrangements for constructing an engine on a larger scale calculated for a 4 h.p., and as we still believed, from the experiments we had made, that it could be applied successfully to aerial navigation, we aimed particularly at lightness in all its parts. The generator was formed of a copper tube ¼in. diameter and 100ft. long, and weighed about 16 lbs. The steam cylinder was formed of sheet copper, was 3in. diameter, 27in. stroke, and weighed with all its appendages about 25 lbs. . . The whole weighed when put together about 115 lbs. A wheel of sails like that of a vertical windmill was attached to it to run horizontally above it with a view to try its power to rise in the air."

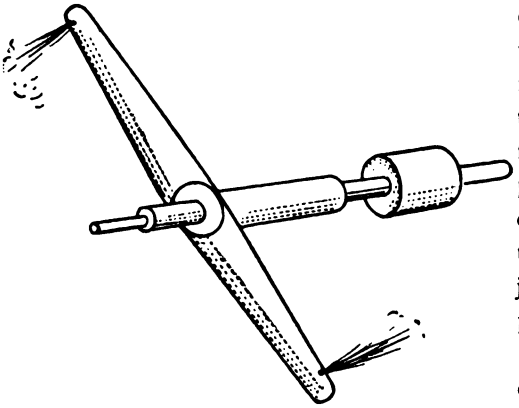
Mr. Buchanan then describes the various causes of failure, and continues: "From these defects we were unable to make it work with more than a single horse-power, and the effect of this power on the wheel of sails discouraged us from proceeding further in that branch of the project."

The inventor, therefore, applied his clever engine to stationary purposes, and after relating its success, he gives the following interesting particulars: "With a view to ascertain what may possibly be done towards aerial navigation by steam, we have made experiments on the power of wings in the air, and on the power necessary to work them. The result is that it requires a horse-power to carry about 30 lbs. in the air, and we do not believe it possible to make a flying engine to be worked by charcoal which would weigh much less than 30 lbs. to the horse-power, wings, condenser, and fuel included. . . We have ascertained by our experiments and calculations that a balloon could be made to carry a man with an engine which would push it at the rate of fifteen miles an hour in the air."

It is a striking and exceedingly encouraging fact how very closely this early experimenter approximates to the results attained by the able workers of our own time, and it is to be regretted his promising motor was not further tried for the purposes of aerial navigation. The above letter, it should be mentioned, bears date July 12th, 1824.

The writer greatly regrets his inability to discover illustrations of this clever engine and boiler, as none appear with the above description.

We have now to mention a very successful application of a very old invention and a suggestion for its use for propelling an air-ship. This is nothing less than the well-known revolving engine of Hero of Alexandria, dating back to 120 years B.C., commonly known as "Barker's Mill." This is another instance of American ingenuity, and is the old Avery engine, of which fig. 3 shows the construction, from which it will be seen the difference (which, although apparently slight, was of the greatest importance) consisted in shaping the revolving arms like the blade of a sword to reduce the resistance to their motion.



FI . 3. Avery's rotary engine.

It is easy to prove that Mr. Avery, by this simple and intelligent alteration, transformed a comparatively ineffective toy into a really practical engine, but before doing this it may be well to quote a part of his patent specification to explain the construction more fully, and it will be remembered that the engine, as usually constructed, consists of a tubular axle having two tubular arms at right angles thereto and communicating therewith. On the opposite side and at the extremity of each arm is a minute aperture, through which the steam escapes, and by its reaction communicates a high velocity to the arms and axis. The improvement mentioned above was not the only one, for as the resistance to the motion of the arms was less when they revolved in steam than in air on account of the difference in their specific gravity, the arms were enclosed in a case or drum, from which the exhaust steam passed off by a suitable opening. The portion of the specification bearing on the shape of the arms is as follows: "We do not claim to be the inventors of the re-acting steam engine, nor of the case or drum within which we intend the arms shall in general revolve, but what we claim as our invention is simply the giving the oblate or flat form to the revolving arms, so that in proportion to their capacity they shall experience much less resistance from the air than that to which they have been hitherto subjected, thereby obtaining a greatly-increased power."

A report then follows of a large sawmill operated entirely by one of these engines with 30in. arms. (See *The Mechanics'*

*Magazine*, vol. xxv., page 415, dated September 17th, 1836.)

In corroboration of this the *Scientific American* states this engine was at work for twenty years, but I shall now quote an amusing suggestion from this well-known paper for the employment of the Avery engine as a medium for aerial navigation, and although it must be considered a fancy sketch, yet if the difficulty of generating enough steam to supply it could be overcome there is perhaps the possibility that the plan might be useful.

In 1860 a Mr. Hyatt, of New York, U.S.A., offered a prize of a thousand dollars for the production of a successful flying machine within a year, and in commenting thereon the *Scientific American* writes as follows: "But the thing that is really wanted is a machine driven by some natural power so that the flyer may ride at his ease. For this purpose we must have a new gas, electrical, or chemical engine. What we now require are two or more substances solid or liquid, which, by merely being brought in contact, would be converted into gas. Place these in the reaction or Avery engine, which, by running at high velocity, would yield a large power in proportion to its weight, and it is possible—yes, probable—that the machine would drive spiral fans with sufficient force to raise itself from the ground. Would not the binoxide of hydrogen and charcoal fulfil these conditions? This engine would run with such immense velocity that the fans would have to be very small, and it is probable that a moderate widening of the arms themselves, giving them a spiral inclination, would be the true plan. There might be two generating vessels corresponding to the steam boiler, and when one was exhausted the second might be brought into action while the supply of material was renewed in the first, thus supplying and exhausting them alternately."

By referring to the sketch it will be observed that the scientific individual in spectacles and shirt sleeves is comfortably disposed in a species of baby's chair over the cylinder, which, presumably, contains the interesting combination previously alluded to, and the gas from which is led through two tubes, on the top of which the propellers are mounted, and the blades of which, being hollow, form a motor on the principle of the Avery engine, which has just been described. (Fig. 4.)

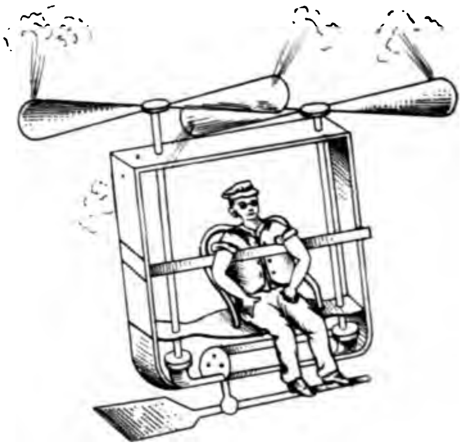


Fig. 4. Proposed application of the Avery engine to the flying machine.

The sketch and description are taken from page 165, vol. iii. (new series), of the *Scientific American* for 1860.

In justice to our great Cornish genius Trevethick, it is right to state that he discovered and patented the Avery engine as early as 1815, but through lack of means was unable to proceed with it.

It is an acknowledged and well-understood fact that in adapting the steam engine to the purposes of aerial flight the trouble is not with the engine itself, the design of which is comparatively easy, but with the provision of a light *boiler*, and this taxed the resources of the early experimenters severely, for it should not be forgotten that the flash boiler, although it was known, was at this time too rudimentary and untried, and the water-tube type (with the exception of Buchanan's clever scheme previously dealt with) was not available in a sufficiently light form to be of much use. In the example now to be shortly described we have a fairly satisfactory attempt to construct a boiler after the *sectional* plan, that is, a series of chambers or vessels connected by tubes.

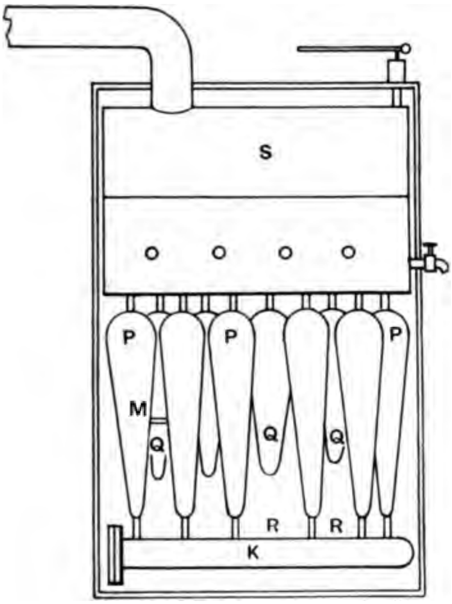


Fig. 5. Henson's steam boiler for his proposed flying machine (side elevation).

This is the arrangement of Mr. Henson, who, in 1843, attempted to build a large steam-driven aeroplane, and although not successful, yet in the adaptation of his machinery showed great ingenuity, and unquestionably greatly assisted later workers by his experience. I regret to state I have been unable to obtain particulars of the engines beyond the fact that apparently to save weight the admission of steam to the cylinders (as also the exhaust) was controlled by cocks instead of slide valves. On the other hand, very full particulars are available as to the boiler—represented in figs. 5, 6, and 7—taken together with the following somewhat condensed description from the *Mechanics' Magazine* for April 1st and 15th, 1843. To take these seriatim, therefore, we find: "The boiler . . . consists of nearly fifty inverted hollow truncated cones from 30in. to 36in. long, and whose larger and smaller diameters are $4\frac{1}{2}$in. and 1in. respectively. These are placed around and above the fire, to the direct action of which they

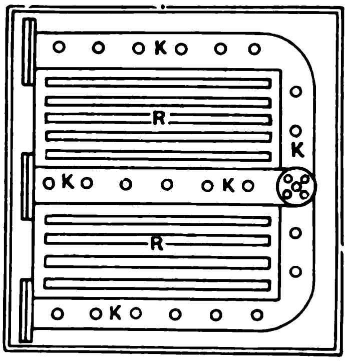


Fig. 6. Henson's steam boiler (bottom plan).

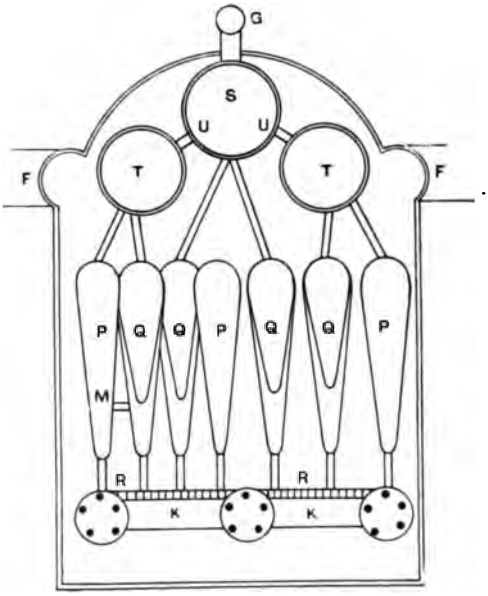


Fig. 7. Henson's boiler (front elevation).

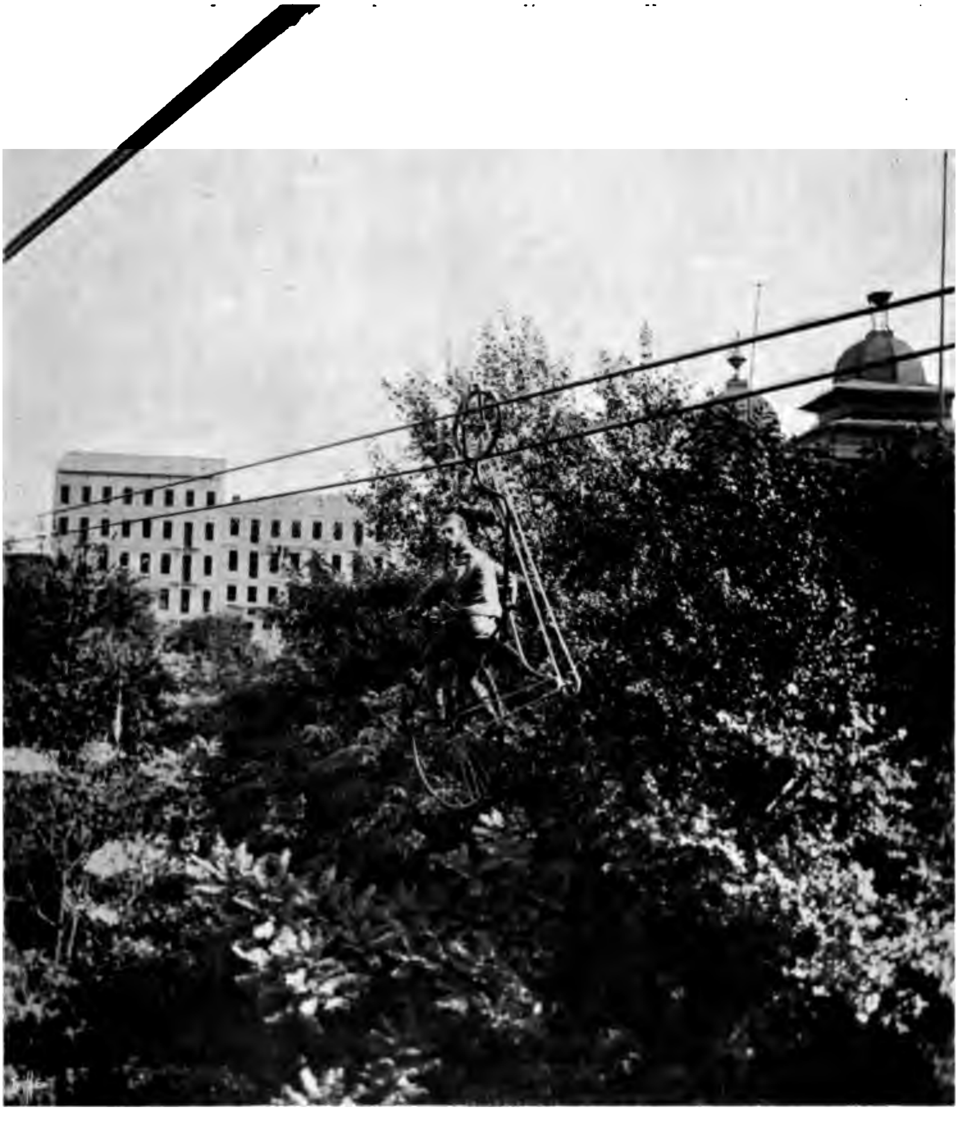
present about fifty square feet, the total heated surface being at least double that amount. . . The condenser is composed of a number of small vertical pipes of thin material exposed to the current of air produced by the flight of the carriage. . . From these data, if realised, it follows that his steam engine will be of about 17 h.p. . . . The quantity of water required to work this engine is but twenty gallons; the weight of the entire engine with water is only 600 lbs.; that of the entire machine, engine, water, fuel, managers, passengers, and cargo ready for flight is estimated to be about 3,000 lbs. The entire weight divided by the entire area gives a load of two-thirds of a pound to the square foot. Many birds are loaded to the amount of an entire pound to the same area. The advantage in favour of the machine is somewhat increased by the known fact that the resistances of large surfaces are somewhat greater on an equal area than those of small ones."

*(To be continued.)*

# The Secret of Aerial Navigation.

In connection with the Leighton Institute, Mr. Eric Stuart Bruce, M.A., hon. secretary of the Aeronautical Society of Great Britain, recently gave a lecture, entitled "Travelling in Mid-air." Mr. Bruce said there never was a time when so keen an interest was taken in aerial navigation as was now the case. He spoke of the invaluable services rendered by means of war balloons during the recent campaign in South Africa. The question might be asked, "How was gas supplied to balloons in war-time?" Experience proved that the most convenient method was by having gas compressed in steel cylinders. Mr. Bruce had some of these steel cylinders on exhibition, and by their aid he illustrated how rapidly a balloon could be filled, experimenting for this purpose on a toy balloon. Another question asked was, "What happened when a gun was fired at a balloon?" The reply was that it did not matter if a balloon was rifled with shots, as it would continue to float because of the upward pressure of the hydrogen. He illustrated this truth by perforating with a dart a floating toy balloon, and the audience saw that the balloon's buoyancy remained unaffected. Mr. Bruce remarked that, even if a balloon was badly torn with shell fire, it would at the worst only float gently to the ground, as was proved by an instance that occurred during the siege of Ladysmith. He explained an invention of his own for securing electric balloon signalling either by the Morse or any other code. He pointed out and illustrated the many advantages of this system, which had been adopted by the British, Belgian, and Italian Governments. The brilliant illumination of the sphere of the balloon by his invention would also give working parties the advantage of continuing their operations by night, while its beacon light promised to be invaluable to exploring parties who temporarily left their ships when on voyages of discovery in Arctic or Antarctic regions. Mr. Bruce's admirable explorations were made the more intelligible by the display of a number of excellent working models, notably one of the Santos-Dumont balloon, also one of the Bruce electrical balloons, and the meteo-parachute.

# AN INTERESTING EXPERIMENT



The above interesting photograph illustrates the apparatus used by Mr. Frederick R. Simms, the well-known engineer, for the purpose of experimenting with an aerial cycle some thirteen years ago. The cable was fixed at a height of 45 ft. to enable Mr. Simms to gather data concerning air resistence, etc. The large wheel of the cycle had a solid cast iron rim acting as a fly-wheel, and wind-guards were fitted in front of the rider's face. The speed attained was nearly 36 miles an hour.

# The Bicycle as an Accessory to True Flight.

By Sidney H. Hollands and G. Lacy Hillier.

[All rights reserved.] *(Continued.)*

## PART IV.—THE MOTOR CYCLE IN FLIGHT.

IN this latest phase of our new cycling system of flight we have to consider (1) what form of prime mover shall be adopted, and (2) how its power can be applied to the best advantage in the special circumstances.

As to the kind of motor to be used, we cannot at present do better than still use the high speed air-cooled petrol motor. This motor, however, should be of specially light design—by preference the recently introduced "Ixion" two-stroke type, which seems unquestionably the lightest petrol motor yet produced, and the simplest—and of not less than 2½ h.p., with provision for the rider to assist it by pedalling.

The latter condition we hold to be an important one, as in the flying bicycle we certainly cannot afford to carry idle power. A muscular and agile rider, as we have seen, could supplement the power of the motor very materially for short periods, therefore let him help.

Now there are two different systems—two practicable media—through which power can be advantageously applied for flight when the aerial vehicle or machine is once air-borne. These are (1) rotating propellers of screw—or approximate—form used in conjunction with an arrangement of fixed sustaining surfaces, and (2) a system of flapping or vibrating surfaces, analogous to the natural wing, and used either with or without those fixed surfaces. The media in the latter arrangement have a two-fold function, constituting propeller-sustainers, as natural wings are; and, as in the former case, propulsion is a means of sustentation.

In the latter arrangement, however, it would be necessary to employ at least two pairs of flapping wings, which would need to be of considerable spread, probably too wide to admit of convenient control of the machine when running on the ground. If multiple wings of shorter radius were used it would involve objectionable complication, besides not being so efficient.

Now a rotative motor, such as the small petrol motor that we propose should be adopted, does not lend itself at all conveniently to the working of reciprocating wings, as no intermediate transmission gear is admissible. At the present stage that internal combustion motors have reached, only a non-rotative reciprocating *steam* motor could be efficiently used with the latter system.

We will therefore, for the present, summarily dismiss flapping wing and analogous propellers, and decide on using a form of continuous rotative screw or fan propeller, in conjunction with fixed surfaces for lifting and sustentation. These surfaces will be preferably of the form and arrangement prescribed for the motorless type of machine.

One of the writers has made a series of comparative experiments with a number of different forms of rotative aerial propeller. These were of from two to six blades, with blades of varied form and pitch, but were all of the same diameter for purposes of fair comparison.

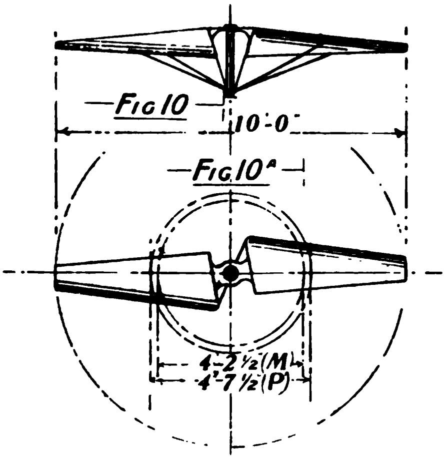
As a result, he has arrived at the following conclusions:

1. That a plurality of blades or vanes is comparatively inefficient, four blades giving better results than six, and two blades better than either.

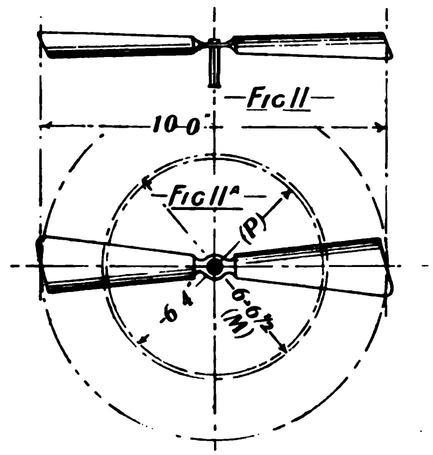
2. That two or more propellers mounted on the same shaft in the wake of each other give no better results than one; in fact, not so good.

3. That a fine pitch is more efficient than a coarse one, *i.e.*, preferably not exceeding 0.66 of the screw or fan's diameter.

4. That it is very advantageous to make the blades with a certain degree of concavity on the drivng side (or "conchoidal"), and therefore convex on the other or advancing side.



M, centre of mass.



P, centre of pressure.

5. That there is a distinct advantage in making the blades narrow at the tip, and broadest near the root, which form is quite contrary to previous practice in aerial fans.

6. That this type of fan-propeller lent itself so well to constructive demands; that a lighter, stronger, and generally better fan of this kind could be made in thin sheet steel than those of the built-up wooden type, such as those used on the Maxim and Langley machines, consequently less power is demanded for a given thrust. The hollow form of blades is found to conduce greatly to strength and rigidity.

We think that at least one reason for the efficiency displayed will be made apparent by figs. 10 and 11.

Figs. 10 and 10a represent the new form of propeller we have described, while figs. 11 and 11a show a propeller of the same diameter, blade area, and dimensions of blades, but with the blades turned end for end, *i.e.*, widest at the periphery, which approximates to the usual comparatively inefficient form of aerial fan-propeller.

It will be seen at a glance that, although the two propellers are of the same outside diameter, the radii of the centre of pressure, and of the centre of mass of blades, are far less in the new form (fig. 10a) than in the other.

This reduction of the radius of centre of mass, not only greatly reduces the centrifugal pull on the blades, but the centre of pressure being correspondingly reduced, the bending moment of the arms, and consequently the pull on the back stays, becomes much less. Both these conditions conduce to lightness of construction.

Besides the structural advantages, the reduction of radii of the two centres reduces the necessary torque, or turning effort.

After all, it is only logical to make the blades narrow towards the region of highest velocity, *i.e.*, at the periphery, and, of course, a regularly increasing area towards the root where the velocity of rotation is least.

As a remarkably light propeller of proved efficiency, we propose that this should be adopted preferably.

The prevailing type of motor bicycle is not conveniently adapted for use in conjunction with aerial apparatus, more particularly as regards the position of the motor. We must therefore resign ourselves to a modified type.

The main departure from present practice will consist in turning the motor round, so that its shaft runs longitudinally, instead of transversely.

It is desirable to still keep the motor in a low down position, as at present, and as nearly on the longitudinal centre line of the machine as practicable. The propeller-shaft must necessarily lie in a fore and aft direction, which will then be in a parallel plane to that of the motorshaft, so that power can be readily transmitted from the latter to the former by means of sprockets and chains. A continuation of the motor-shaft will drive the rear road wheel -with the centre of which it must be lineable - through the medium of small bevel gearing (one pair). Pedals and sprockets for auxiliary driving will have to be provided, and placed in approximately the ordinary position. In view of the expediency of always having the latter available as a serviceable auxiliary, and for starting purposes, the motor transmission gearing to the rear road wheel will always remain in gear. On the other hand, the driving sprocket on the motor continuation shaft, for running the aerial propeller, will preferably be designed to be thrown out of gear while the machine is running on the ground, so that all the available power can be concentrated on the road driving wheel, through which medium it can be applied to better advantage in terrestrial propulsion.

The aggregate area of lifting and sustaining surfaces for the flying motor bicyle will necessarily be greater than in the case of the motorless machine by perhaps twenty-five to thirty per cent., due to the additional weight of motor, together with heavier structure of framing, etc. This increase of area, however, is obviously not so great as would be necessary if the extra weight did not provide largely increased power available for higher speed.

It is, of course, expedient to keep the centre of gravity of the machine as a whole as low as practicable, and this desideratum will be favoured by the low down position of the motor, tending, as it does, to reduce the height of sustaining superstructure. It will in this respect have another advantage over the motorless machine, as not only is the height of sustaining superstructure thereby admissibly reduced, but the centre of thrust of propeller can be brought more nearly in line with the centre of resistance of lifting surfaces. Obviously, the more these centres approximate the better, but the structure will not admit of their being brought quite coincident.

With regard to the adoption—with the advanced motor machine of the "feathering" appliance, as previously described herein for use with the elementary motorless machine, it must be said that, until actual experiments have been made with this appliance on the latter, we cannot tell with any degree of certainty the extent of the advantage derivable from it. It is a question to be determined by actual trial only, but it is quite probable that for the neutral position it will be found that the aerocurves will have to assume a ***negative*** angle with the plane of motion, rather than having the chord of the curve horizontal or parallel to the plane of motion.

An ***aeroplane*** in the latter position, and travelling in a horizontal course, would, we know, be absolutely neutral as regards lifting, but ***aerocurves*** have widely different properties, the two forms of surface having little in common.

An aerocurve set with the chord of its arc horizontal, and in a horizontal wind, has actually been found to exert a considerable lifting effort, as much, in fact, as an aeroplane set at a small positive angle of incidence.

If in the present advocated course of experiment it should be found practicable to set, and have permanently fixed, the sustaining aerocurves at such a small positive angle as would produce but a small amount of "drift" (or forward resistance), and would admit of the motor cycle attaining its maximum speed—or nearly so—before lifting was effected, an important advantage would be gained. This would consist not only in the avoidance of any adjustable or movable parts in the lifting and sustaining apparatus, together with the consequent simplification, and reduction of weight in a rigid structure for a given strength, but probably also an increase in the efficiency of the apparatus.

With the much higher speed attainable on a motor machine, we stand a considerably better chance of finding the fixed aerocurves and the rigid structure of aviator proper to be not only admissible, but more efficient. The reduced "drift" due to the small angle of incidence of the aerocurves rendered admissible by the higher speed of transit, and the high speed itself, both conduce to increased efficiency.

The remarkable fact discovered by Prof. Langley in his aerodynamic experiments—viz., that with a certain form of aerocurve the resistance to forward motion is actually ***reduced*** after a certain high velocity has been reached, or, in other words, that at very high speeds with such apparatus ***less*** power for propulsion is demanded than for lower speeds—appears paradoxical, certainly, but we believe it may safely be accepted as a fact: it turns on the great difference between the behaviour of a flat surface normal to the direction of wind pressure and a suitably formed curved surface at a small angle of incidence, or even with the chord of the curve parallel to the plane of motion, *i.e.*, horizontal. This fact, we say, is again all in favour of our advanced high speed motor cycle aviator.

With our elementary man-propelled machine, we roughly estimated that a speed of about fifteen miles an hour would be the maximum attainable.

With the advanced motor machine, supplemented by the full power of a muscular and active rider, we might reasonably estimate the attainable speed to be not less than twenty-five miles an hour.

*(To be concluded.)*

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Telling of one of his journeys above the clouds, an aeronaut described the scenery as a "fairyland of inexpressible beauty—and there they were for two hours enjoying life to the fullest extent."

* * *

Mr. Harold Norfolk, of the 13th Hussars, made a balloon ascent for reconnoitring purposes at Aldershot. The Hog's Back was crossed at an altitude of 5,000 feet, and after passing over splendid country, a good descent was made one mile from the sea at Angmering. Mr. Spencer was the aeronaut in charge.

# Twenty-four Years of Ballooning.

On March 20th the members of the Aeronautical Institute and Club assembled at St. Bride's Foundation Institute to hear Mr. Auguste E. Gaudron, the well-known aeronaut and balloon manufacturer, of London, lecture on "Twenty-four Years of Ballooning." Dr. F. Alexander Barton (president) occupied the chair, and amongst those present were Col. Yorke, R.A., Major Berthon, Messrs. O. L. Senecal (founder of the Institute), Henry Spencer, L. Taylor, H. Baker, F. L. Rawson, Rajaram Parwalkar, and Messrs. Field and Dwyer (honorary secretaries). For nearly two hours the lecturer riveted the attention of his audience in narrating a series of exciting experiences which had befallen him during a lifetime spent in experimental and exhibition work, and we regret that space will only permit us to refer briefly to a few of these.

MR. AUGUSTE E. GAUDRON.

### Early Experiences.

Gaudron's taste for aeronautics began as far back as 1878, when the famous Paris

Exhibition balloon, having a capacity of 785,000 cubic feet, and capable of carrying fifty passengers at a time to a height of 1,800 feet, caused a feeling of wonderment which was intensified by the innumerable balloons sent up from the exhibition at the same period.

In 1879 he came in contact with M. Lachambre, and readily assented to become his apprentice in the business of an aeronaut and balloon manufacturer. In this position he stayed seven years, proceeding through every department. During the same period he made numerous ascents with his employer in various parts of France, the first being in 1881. He made his first ascent alone in 1882 from Messrs. Tissandier's experimental grounds, and was hailed as the youngest aeronaut of the time.

Soon after he had an exciting experience at Noisy-le-Sec, where, in order that the people might not be disappointed, and although the supply of gas was bad, he detached the car and ascended sitting in the hoop. Proximity to the open neck of the balloon partially asphyxiated him, and he lost consciousness and remembered nothing more until he awoke next morning in his home at Paris. From subsequent enquiries it transpired that he had been found lying insensible in a haystack, and his discoverers, finding an address in his pocket, had him conveyed there. During another ascent he was dragged for three miles over ploughed fields near Etaples, with no hedges to assist in pulling up the balloon, which, being released, collapsed across the rails shortly before the Bordeaux express was due to pass. The balloon was only cleared away just in time to prevent disaster.

During his apprenticeship he made in all 150 ascents. He then commenced to travel, went with an inventor to Brazil, and thence to Brussels, where he took charge of an ascent for a lady gymnast who used to go up hanging by her teeth to the trapeze under the balloon, being taken into the car when reaching a certain height. He travelled with this lady as manager through Austria, Hungary, Germany, Poland, and Russia, and in 1888 they came to England and made six ascents at the Crystal Palace, six at the Irish Exhibition Olympia, and two at Leicester.

### AN EXCITING TRIP.

Mr. Gaudron then decided to stay in England and establish himself in business for the manufacture of goldbeaters' skin balloons, an idea which received the support of Mr. Chas. G. Spencer. About the same time Mr. T. S. Baldwin came to this country and created a sensation by his parachute descents. Not to be outdone, Mr. Gaudron commenced in the same direction, his first flight taking place at the Hastings Cricket Grounds, and proving a sensational one in many respects. In less than ten seconds he was carried out to sea, and was soon completely lost to sight. He made his jump, and in about two minutes after leaving the balloon his feet touched the water, where he managed to keep himself afloat by means of a life belt, with which he had provided himself, until a steamer putting off from land rescued him. Since then he has made no fewer than 500 descents, all more or less having a tinge of excitement or danger in them.

Leaving England, he proceeded on a tour through Russia, making many parachute descents in the principal towns. One at Nijni Novgorod nearly ended in a tragedy. When 6,000 feet high he jumped from the balloon, and, forgetting to remove himself from the sling of the rope attached to the trapeze, descended with no other support but his hands. His strength gave way owing to an illness from which he was suffering, and when 500 feet from the lake into which he desired to fall, he was holding on by the tips of his fingers. By a superhuman effort he roused himself, slung his legs upward, and, thrusting them through the lines of the parachute, came down into the water head first.

He returned to England *viâ* Constantinople, Malta, and Gibraltar, and made forty-nine ascents at the Military Exhibition, carrying during that period over 400 passengers, and it came to his knowledge afterwards that these included a couple on their honeymoon.

On one of these ascents he had for a companion Sir Vincent Barrington, and there was a spice of adventure in the trip. Owing to the condensation caused by a coming rainstorm, the balloon would not rise for more than 1,200 feet, so an attempt was made to land in a large garden, and to prevent knocking off chimney pots and other projections everything had to be slung overboard, including overcoats. The anchor was cast in the garden, but it got mixed up in the chimney stack, pulled off the pot, and ultimately went through the drawing room window before a landing was safely effected.

### A Dangerous Situation.

Mr. Gaudron, having married, started for another tour, extending over three years, during which period he made many ascents in Italy, Austria, Greece, Turkey, Russia, and the Caucasus. At Trieste he nearly lost his life owing to a slight misunderstanding. When asking for the trapeze bar to be handed to him, the interpreter misunderstood the signal for one to let go the balloon, and as the vehicle was not provided with a valve (such balloons never are) he soon found himself over the sea at a great altitude, with no visible means of safe descent. He calmly surveyed the situation, and ultimately decided to climb up the netting of the balloon until it should partly overbalance and allow a quantity of gas to escape from the open neck. This required especial care, for if the gas escaped too rapidly he would have been dashed into the sea below with frightful rapidity. His situation was a most unenviable one, for he had a rope of only half an inch in diameter for a seat, and was by this time 4,000 feet high. To remain in the balloon was certain death, so he proceeded cautiously to climb the netting, and when the neck was about two-thirds up he found the gas began to rush out, and the balloon fell with great rapidity, though the rush of air formed it into a sort of parachute. In about four minutes he fell on his back in the water, nearly three and a half miles from shore. A steam tug picked him up shortly after, and he was conveyed to shore. Mr. Gaudron declared that for all the wealth in the world he would not go through his Trieste adventure again.

### The Sultan Objects.

An attempt to ascend in Constantinople was frustrated because the Sultan was afraid he would get too good a view of the private gardens and see some of the ladies of the harem. Odessa, the Caucasus, Baku, and Astrachan were subsequently visited, and at the latter place an ascent was made during the time of the cholera riots. The burning hospital, which had been set alight by the rioters, was visible from the balloon, and on his descent Mr. Gaudron learnt that paraffin had been poured over a medical officer who was then burned to death. After a visit to Moscow he returned again to England, and in a trial ascent at Enniskillen the strong wind forced the balloon down to the ground several times; it burst open, and he was carried off the field with a sprained ankle and a shock to the nervous system.

### TWO UNWILLING PASSENGERS.

Captive ascents at Glasgow next followed. During one of these the rope snapped, and the balloon rapidly ascended, carrying himself and two unwilling passengers. The latter were very frightened, and huddled in the bottom of the car praying with all their might, while he tried to cheer them with the thought that they were having £5 worth for 2s. 6d. Time after time he endeavoured to persuade them to gaze on the beautiful panorama of Glasgow 8,000 feet below, and eventually put them out of their misery by descending safely at Paisley. It was at the Alexandra Palace soon afterwards that he made the first successful attempt to take up and bring down a balloon with an oil motor attached. The motor was of 3½ h.p., with double horizontal cylinders fixed on a platform, and actuated an eight-foot propeller placed in the forepart of the balloon, making 160 to 200 revolutions per minute. At the opposite end of the balloon a rudder was placed, which could be controlled from the aeronaut's platform. Notwithstanding the small power of the motor and the high wind which prevailed, Mr. Gaudron was able to deviate at times to an angle of thirty degrees. If he had the necessary funds he would now conduct a series of experiments on a large scale, and compete with M. Santos-Dumont.

### A PLUCKY LADY PARACHUTIST.

He made a double parachute ascent with a lady in 1899 at Spalding, when, owing to the bungling of an attendant, the parachute was detached, and they ascended with it hanging downwards, the rapidity of progress almost pulling the lady out of her seat. Mr. Gaudron pulled in the lines of the parachute until he reached the apex, explained matters to the lady, who pluckily said she would do anything he told her. He accordingly held the top of the parachute while she jumped, and he had the satisfaction of seeing her reach *terra firmâ* in safety, where he soon afterwards joined her. The altitude reached on this occasion was 10,000 feet, and it took twenty minutes to descend. He had a similar experience at the Alexandra Palace during his three seasons there, when he made 120 parachute descents. Mr. Gaudron then narrated the experiences of himself and Dr. Barton on Coronation Day from Beckenham, an illustrated description of which has already been given in these pages. He next referred to the instructional ascent, under the auspices of the Institute, at Beckenham, last August, when Messrs. Field and McNair accompanied him on a highly successful trip. The ascent at Bath in September last, intended to celebrate the centenary of the first ascent from that city by M. Garnerin in 1802, was next referred to. At the dinner which followed, Major Baden-Powell, Major Trollope, the Hon. C. S. Rolls, Dr. Barton, and a host of others interested in aeronautics were present.

### SHOOTING A BALLOON.

One of his most recent ascents was made at Manchester in February last in company with Dr. Barton in aid of the Lifeboat Fund. The balloon on this occasion had a capacity of 40,000 feet, and an excellent trip was made. During the ascent, and when 3,000 feet high, they were startled by hearing the report of a gun, and a bullet passed through the netting of the balloon, a second shot coming nearer the car. It was afterwards ascertained that the shots were fired by some volunteers who were out practising, and the offenders, being discovered, were deservedly punished. They pleaded that they had mistaken the balloon for a toy one, and had shot at it for a lark!

In concluding his interesting address Mr. Gaudron said he had the satisfaction of knowing that he had introduced some improvements into balloons during the period he had resided in this country, including the method of making a pear-shaped balloon from a sphere--a more economical mode of cutting out the material for balloons; the making of a net in half the time previously occupied; the extension of car lines right through the wickerwork; and improvements to the suspension hoop and bridge valve. He was of opinion that no other sport could compare with ballooning, which took one into the purest air, and afforded the loveliest views of the beauties of nature without the slightest fatigue.

The proceedings terminated with a series of interesting lantern slides depicting some of the lecturer's trips and ascents made by members of the Institute, thus bringing to a close an interesting and instructive evening.

# An Interesting Aeronautical Exhibition.

AT the conversazione of the Junior Institution of Engineers held at the Westminster Palace Hotel, London, on March 14th, Mr. C. H. M. A. Alderson was in charge of exhibits from the Aeronautical Institute and Club. In addition to a bi-plane foldable kite made by Mr. Alderson himself, there were several items of historical interest loaned by Mr. F. Stringfellow, of Crewkerne, Somerset. This latter gentleman has devoted not a little trouble and expense to the problem of aerial navigation, and he is credited with having secured the first successful rise of an aerial machine by mechanical motive power. The bi-plane kite shown by Mr. Alderson was suspended from the roof, and was 10ft. from tip to tip and 8ft. longitudinally, supporting areas at a diedral angle. The kite, which is reputed to be a steady flier, is collapsible into a small compass by touching a spring. Mr. Stringfellow's contribution to the exhibit comprised an enlarged coloured picture of Henson's proposed machine (1842-3) car; part of old tail propellers from a model of the machine made by Messrs. Henson and Stringfellow (1847); tail, wings, and propellers of the first machine to fly by motive power (a rise of one in seven by this machine was witnessed by a number of persons at the period of experimenting); two large photographs of the Crystal Palace machine of 1868, etc.

In addition to the Institute's contribution, Mr. Wm. Cockrane's mechanical fin method for propelling and steering ships and flying machines was also on view.

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Sir Hiram Maxim is of the opinion that if there is an exhibition of dirigible balloons at St. Louis very few of them will be able to return from the point of departure. It will be found, he thinks, that when these balloons ascend they will travel with the wind just exactly like any other balloon, no matter which way they are pointed, and that they descend to the earth just like other balloons, and have to be dismantled and sent back to the point of departure by some means of land conveyance.

# The Late Mr. James Glaisher.

DURING the month of February there passed away at the ripe old age of ninety-four years the doyen meteorologist of the last century, Mr. James Glaisher, F.R.S., of Croydon. Although a scientist of no mean repute, it was as an aeronaut that he was better known to the great bulk of the public. As a matter of fact, it was his taste for atmospheric phenomena and his desire to further science that led him, in company with Coxwell, to undertake a very memorable balloon ascent in 1863, when he attained the highest altitude even yet reached.

*Photo by H. J. Whitlock & Sons, Birmingham.*

THE LATE MR. JAMES GLAISHER.

Glaisher had faith in the balloon as an instrument of atmospheric inquiry, and largely owing to his advocacy the British Association appointed a committee to co-operate with him in the research. The objects in view were to determine the temperature of the air and its moisture at different elevations, as high as possible, to test its electrical condition, the height and kind of clouds, their density and thickness, and the rate and direction of currents in the atmosphere. For these purposes Mr. Glaisher took up a large number of high-class scientific instruments. His first ascent with Coxwell was made from Wolverhampton, on July 17th, 1862. They rose to a height of five miles, travelled sixty miles in two hours, and descended just in time to avoid a dip in the Wash. Two important things were learnt on the excursion: first they passed through a cloud 8,000 feet in thickness, and so dense that the balloon was invisible from the car; and second, they dropped 3,900 feet—from 16,300 feet to 12,400 feet—in one minute. But the great historic ascent, made from Wolverhampton, took place on September 5th, 1862, when the highest point ever attained by men who survived to tell the tale was reached. Mr. Glaisher relates:

"At 1h. 51m. the barometer read 10.8in. About 1.52 or later, I read the dry bulb thermometer as minus five degrees; after this I could not see the column of mercury, nor the hands of the watch, nor the fine divisions on any instrument. I asked Mr. Coxwell to help me to read the instruments. In consequence, however, of the rotary motion of the balloon, which had continued without ceasing since we left the earth, the valve line had become entangled, and he had to leave the car and mount into the ring to readjust it. I then looked at the barometer, and found its reading to be 9¾in., still decreasing fast, implying a height exceeding 29,000 feet. Shortly after I laid my arm upon the table, possessed of its full vigour, but on being desirous of using it, I found it powerless. Trying to move the other arm, I found it powerless also. Then I tried to shake myself, and succeeded, but seemed to have no limbs. In looking at the barometer my head fell over my left shoulder. I struggled and shook my body again, but could not move my arms. Getting my head upright, for an instant only, it fell on my right shoulder; then I fell backwards, my back resting against the side of the car, and my head on its edge. In this position my eyes were directed to Mr. Coxwell in the ring. When I shook my body I seemed to have full power over the muscles of the back, and considerably so over those of the neck, but none over either my arms or my legs. As in the case of the arms, so all muscular power was lost in an instant from my back and neck. I dimly saw Mr. Coxwell, and endeavoured to speak, but could not. In an instant intense darkness overcame me, so that the optic nerve had suddenly lost power, but I was still conscious, with as active a brain as at the present moment while writing this. I thought I had been seized with asphyxia, and believed I should experience nothing more, as death would come unless we speedily descended. Other thoughts were entering my mind, when I became unconscious, as on going to sleep. I cannot tell anything of the sense of hearing, as no sound reaches the car to break the perfect stillness and silence of the regions between six and seven miles from the earth. My last observation was at 1.54, above 29,000 feet. . . . Whilst powerless, I heard the words 'temperature' and 'observation,' and I knew Mr. Coxwell was in the car speaking to and endeavouring to raise me, therefore consciousness and hearing had returned. I then heard him speaking more emphatically, but could not see, speak, or move. I heard him say again, 'do try, now, do.' Then the instruments became dimly visible, and Mr. Coxwell, and very shortly I saw clearly. I said to Mr. Coxwell, 'I have been insensible'; he said, 'You have, and I too very nearly.' He told me he had lost the use of his hands, which were black, and I poured brandy over them. Mr. Coxwell told me that while in the ring he felt it piercingly cold, and that on attempting to leave the ring he found his hands frozen. He had, therefore, to place his arms on the ring and drop down. He wished to approach me, but could not, and when he felt insensibility coming over him too, he became anxious to open the valve. But in consequence of having lost the use of his hand he could not do this; ultimately he succeeded by seizing the cord with his teeth, and dipping his head two or three times, until the balloon took a decided turn downwards. . . . The descent took place at Cold Weston, seven and a half miles from Ludlow."

Thus one of the aeronauts was insensible, and the other had only the use of his teeth left, with which to open the valve, and on that their safety depended. The height to which they had attained is without parallel. Mr. Glaisher says:

"My last observation was made at a height of 29,000 feet, at 1.54, when we were ascending 1,000 feet per minute, and when I resumed observations we were descending 2,000 feet per minute. These two positions must be connected, taking into account the interval between them, thirteen minutes. And on these considerations the balloon must have attained an altitude of 36,000 or 37,000 feet. Mr. Coxwell, on coming from the ring, noticed that the centre of the aneroid barometer, its blue hand, and a rope attached to the car, were all on the same straight line, and this gave a reading of 7in., and leads to the same result. Therefore, these independent means all come to about the same elevation—fully seven miles."

According to a writer in the *Daily Telegraph*, Glaishier made altogether twenty-nine balloon ascents for scientific purposes. The most important fact, probably, which he demonstrated was the frequent existence in the atmosphere of upper currents, which, contrary to expectation, were warmer than currents below. In many cases the thermometer, on passing from an inferior stratum to one above, rose as much as ten degrees. Every observer is aware that often the highest clouds will be still, while lower down the scud is flying rapidly, and beyond the still layer the aeronaut may reach one moving in the opposite direction to that beneath, and of a higher temperature. While, as a rule, temperature falls as one ascends, there are wide variations, and as to weather the utmost variety. In an ascent made at Wolverton in 1863 Glaisher entered a cloud at 4,000 feet, and, emerging from it, found, instead of the usual sunshine, dark clouds above. Then at successive elevations up to four miles the aeronauts passed through dry fog, faint sunshine, thin rain, wetting fog, dry fog, gleams of the sun, renewed fog, gradually getting more damp, until 19,600 feet high was reached, when fog ceased. Approaching four miles high there were still dense clouds above; only at 23,000 feet were they above cloud-level. In the descent they passed through a snowstorm—in the air only, it never reached earth—a beautiful, snowy scene, with no flakes, but only minute crystals of ice.

Glaisher was one of the very first to take photographs from balloons. His reports were published in the proceedings of the British Association, and the substance of them is reproduced to some extent in his "Travels in the Air." He was also the author of more than a hundred works on astronomy, meteorology, and the theory of numbers, among them being a translation of "The Atmosphere," by Flammarion, and "The World of Comets," by Guillemin. Mr. Glaisher was president of the Royal Microscopical Society, of the Photographic Society of Great Britain, and chairman of the executive committee of the Palestine Exploration Fund. He was a member of the Royal Commission on the Warming and Ventilation of Dwellings, appointed in 1857, for which he conducted the experiments and penned the report. He was a member of the staff of the Royal Observatory at Greenwich, and when he retired he was the superintendent of the Magnetic and Meterorological Section.

# The Aeronautical Society.

MR. JOHN ANDERSON last month contributed a very interesting paper on "The Kite Equipment of the Scottish National Antarctic Expedition" before the members of the Aeronautical Society of Great Britain at John Street, Adelphi, London.

Lantern illustrations showed the construction of the kite and its steering apparatus. In the author's absence, Mr. Eric S. Bruce read the paper, which emphasised the utility of the kite for meteorological surveys, and of its employment in the recent expedition from the Clyde to the South Polar regions under the leadership of Mr. W. S. Bruce. The steering apparatus was made of steel piano-wire, while the ordinary petrol motor that was associated with motor cycles proved of inestimable value in a pull against the wind.

Mr. Patrick Y. Alexander followed with some interesting observations upon the aerosac as the result of certain experiments he has been making. The device has been in use in Japan for many years, and it was remarkable to notice the extraordinary stability it possessed in sailing against the wind.

Major Blackden, of the West India Regiment, also contributed a paper on "Observations and Experiments relative to Equilibrium in Air of a Body heavier than Air." It evinced a profound study of the soaring movements of vultures in Sierra Leone, from which he was able to deduce the fact that the bird could soar in absolutely still air. Speaking of the balancing powers of the gull, the gallant officer said he once saw a gull scratch its head, which palpably interfered with its equilibrium for the moment - an observation that created considerable merriment among the assembly. By a series of diagrams on the blackboard, Major Blackden illustrated how in his observations of the movements of these birds on the wing the lessons could be applied in the construction of the kite. He invited all experimenters like himself to put the result of their studies into the common stock, to ignore all selfish ends, and thus, he believed, by a common endeavour they would finally win their empire over the air, and which it was one of the objects of the society to achieve.

A sad prelude to the ordinary business of the evening was a vote of condolence with the widow of the late Mr. J. Glaisher, one of their most prominent members, passed on the motion of Major B. F. S. Baden-Powell, and seconded by Major Roberts.

# French Notes.

### WINTER EXPERIMENTS.

THE winter is not usually favourable to ballooning. But in a country where the balloon is regarded as a valuable means of national defence it is rare that any considerable time is allowed to elapse without an effort being made to develop the science of aerial navigation, for every new experiment aims at bringing the balloon more and more under control and rendering it to a certain extent navigable. There are two problems that occupy the attention of the French balloonist, the one to remain in the air the greatest possible time and cover the longest distance without taking into account the direction so long as the balloon does not make for the sea, and the other to control the aerostat and descend as near as possible to a place fixed beforehand, either by means of guide ropes or other contrivances, or by utilising the air currents at various altitudes, which, of course, is largely a matter of chance. The last few months have seen many interesting attempts of this kind, very few of which have succeeded. Count Henry de la Vaulx's attempts to cross the Mediterranean by employing the Hervey "stabilisator"—a sort of big venetian blind, which opens in the water, and, while serving to keep the balloon at a fairly level altitude, allows of its being navigated through a certain angle—have failed because of contrary winds, and in Algeria recently some large pilot balloons were sent up in order to ascertain whether the winds blowing across the desert were constant, but the balloons described a half circle, and were picked up by a caravan of Arabs a long way out of their course. The idea of opening up regular balloon communication across the Sahara has therefore been abandoned. The other day Messrs. Maurice and Dick Farman, accompanied by Mrs. Farman, were carried from Paris to somewhere in Denmark at the rate of more than fifty miles an hour, and had a great deal of difficulty in safely landing in the gale; but previously another balloon rose from Paris through a fog, and, after spending the night in the air, descended within half a mile of the place it started from, much to the astonishment of the aeronauts, who had feared that they were being carried out to sea. Such are some of the surprises of ballooning.

### SANTOS-DUMONT'S PLANS.

In the way of navigable balloons the winter has naturally been destitute of practical work. Inventors do not usually care to test their machines before the summer, when the days and nights are less liable to changes of temperature and weather, and what is being done now is purely a work of preparation. M. Santos-Dumont is credited with the intention of building a shed at the Porte Maillot on the site which was last year occupied by a captive balloon, but, on the other hand, he has received an invitation from the Aero Club to continue his experiments on the club's grounds at Saint Cloud. M. Santos-Dumont has wisely decided to take no one into his confidence, so that little will probably be known of his new balloon until he is fairly assured of success. As we have before stated, M. Santos-Dumont hopes to construct a real airship that will carry half a dozen passengers or more.

### DIRIGIBLE BALLOONS.

Meanwhile, quite a large number of inventors are busily working upon the problem of the dirigible balloon. There is one at Lyons who hopes to have an airship ready in the summer. The plans have appealed so strongly to local capitalists that they have supplied him with all the money he needs for its construction. If the motor balloons now reported to be on the stocks are completed, there will be quite a dozen in France during the next six months, but if we can get half this number we shall be perfectly satisfied, for there is nothing more illusory than the promises of inventors. Their intentions are good, but the motor balloon is not yet a commercial success, and capital holds aloof.

### Successful Inventors.

For the moment, the inventors who, apart from M. Santos-Dumont, seem to have success most nearly within their grasp are the Messrs. Lebaudy, whose balloon last autumn made two or three private ascents in the seclusion of a village known as Moissan, situated not far to the west of Mantes. As millionaires, the Messrs. Lebaudy have a distinct advantage over other inventors, or, rather, they have built the balloon to the plans of an aeronautical engineer who has entered their service, and thereby hangs a tale, as well as certain proceedings, for an alleged counterfeiting of plans. A Corsican balloonist has brought this action against Messrs. Lebaudy on the ground that the plans were communicated by him to their engineer. The case is now proceeding, and is exciting a good deal of interest on account of its novelty.

### The Trials of the Balloonist.

It is evident, therefore, that even the successful motor balloonist is not without his trials and tribulations, but when the inventor of airships fails, his troubles increase tenfold. This is the case with M. Roze, who, it will be remembered, constructed a very complicated arrangement of twin balloons which was intended to have the same weight as the air the machine displaced. Between these two elongated aerostats was a large double-decked car, with the upper deck for the propelling machinery, and the lower one for the passengers, of whom about a dozen would be taken up at a time. There were two driving propellers, and two for raising the machine, for the inventor supposed that with the aid of the aerostat it would require very little effort to raise it from the ground. Unfortunately, the trials last year were a complete failure. The machine was unable to move an inch from the ground, and when the spectators gave it a lift the airship dropped heavily. M. Roze declared that the failure was due to a condensation of gas, and then he attributed it to the weight of the silk, and wanted to procure lighter envelopes. But the private syndicate who had been supplying the capital would not provide fresh funds. The machine remained a melancholy failure in its shed until a few weeks ago, when the members of the syndicate ordered it to be broken up and sold as scrap material. M. Roze is indignant, and declares that his life's work is destroyed just at the moment when he was looking for success.

### Military Ballooning.

Yet another incident in motor ballooning is the reorganisation of the military station at Chalais-Meudon, where the brothers Renard are understood to have been engaged on the construction of an electric machine which was to be an improvement on the "France." Nothing, of course, is ever made public as to what is taking place at Chalais-Meudon, but a recent decision of the Minister of War, and rumours pointing to certain divergences of opinion, seem to imply that the work of invention in the way of military dirigible balloons is not proceeding so smoothly as might have been expected. Possibly Colonel Renard may be a little behind the times. He has always refused to admit that any real progress has been made in aerial navigation since he constructed the "France" in conjunction with Major Krebs, and he still regards the petrol motor as a dangerous adjunct to the aerostat.

The balloon never did better service than during the siege of Paris, when it was used to open up communication between the invested city and the provinces, and nothing was more remarkable than the way in which the service was organised by men who, at that time, had only a very imperfect knowledge of aeronautics. It was by a balloon that Gambetta left Paris to reorganise the army of the Loire, and for some months the only communication with the outside world was by means of the "balloon post," carrying microscopic letters, of which many are still preserved. The Prussians only succeeded in capturing two of the balloons, one of them piloted by an Englishman, Mr. Worth, who was sent to a German fortress. To commemorate the heroism of the men who crossed the lines of the investing army in imminent danger of being brought down by bullets it has been decided to organise a national subscription for the erection in Paris of a monument which has been sculptured by Bartholdi. The subscription is under the patronage of the President of the Republic and of members of the Government, and there is no doubt that it will be a great success.

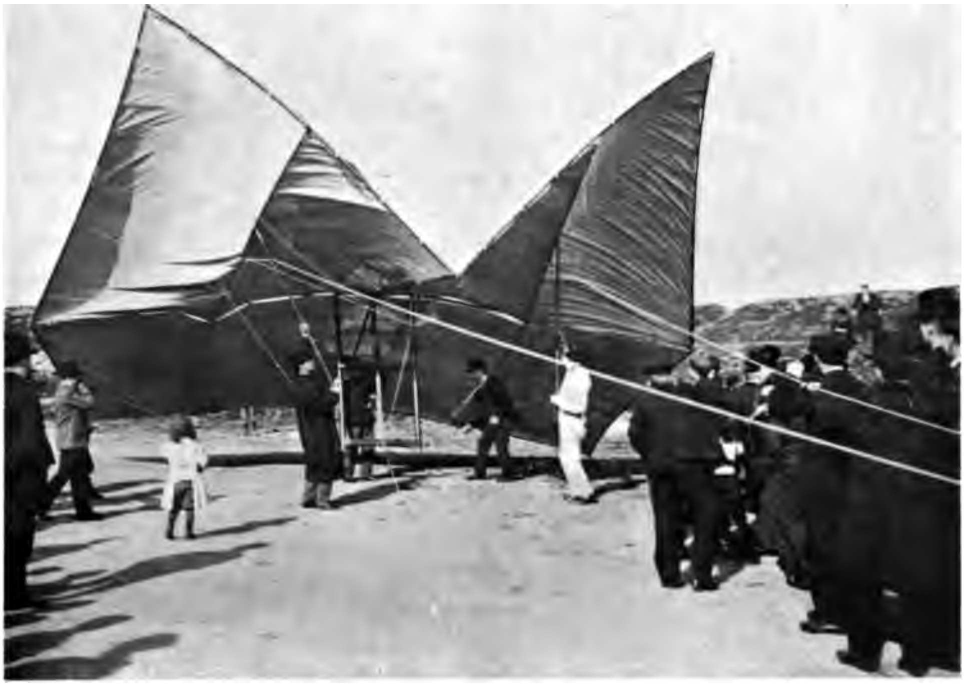

*Photo by Augustin Richgit.*

A new military kite in which the inventor, Monsieur Farbe, recently made a successful ascent at Vincennes. The kite is intended as a substitute for the captive balloon on windy days.

# The Irreligion of Flying.

## A Peep into the Past.

WHATEVER obstacles impede the progress of the aeronaut of to-day, he may at least flatter himself that he does not incur the "odium theologicum" as he would have had to do 150 years ago. In 1740, the fifth edition was published of a little work called "Nature Display'd, being Discourses on such Particulars of Natural History as were thought most proper to Excite the Curiosity and Form the Minds of Youth." These edifying discourses are presented in the form of a series of imaginary evening conversations in an English country house between a Count and Countess, who are host and hostess also, a youth of quality who is entitled the Chevalier, and the "Prior-Curate of the Place."

One evening their quaint conversation is made to turn on the flight of birds, and the prosy ecclesiastic winds up a protracted speech with these sentences: "The Tail is a Counterpoise to the Head and Neck, and serves the Bird instead of a Rudder, whilst he rows with his Wings; but this Rudder is not only instrumental in preserving the Equilibrium of the Flight: it likewise enables the Bird to rise, descend, and turn where he pleases; for as soon as the Tail is directed to one Point, the Head turns to the opposite Quarter."

The conversation then becomes general and of great interest.

Chevalier: Though I do not comprehend how Birds perform their Flight, I am of Opinion it is not impracticable for Man to imitate them; and the Birds instruct him in the Method he ought to observe.

Prior: It is certain that we have the Principle of Motion in our Legs and Arms; we likewise have, in the Feathers of Birds, and in our Linnen Cloth and Oil, Materials of a seeming Fitness to form Wings, capable both of striking and impelling the Air, without being penetrated by it. The Birds supply us with a Model of the Action, and at first View it seems to be an Invention naturally presented to us, and which a small Effort, or a few Reflections, would suffice to make us acquire in Perfection; but I believe God, in consequence of His providential Care of Mankind, has opposed an insuperable Impediment in the Way; so that this Attempt, which has been frequently repeated, hath always proved unsuccessful. The Art of flying would be the greatest Calamity that could happen to Society.

Chevalier: On the contrary, Sir, I should think this Invention would save us abundance of Labour. We should be sooner acquainted with what we are desirous of knowing; and if we had once found out a small Machine, could soon build a larger. We should not only traverse the Air ourselves, but might likewise convey Cargoes of Merchandize through that Element. By this Means Commerce ——

Prior: You have a charming Penetration, Chevalier, and are the best in the world at guessing the Advantages we might receive from this Invention; but these Advantages would not countervail the Disorders that would be introduced.

Count: This is certain, that, were Men capable of flying, no Avenue could be inaccessible to Vengeance and inordinate Desires. The Habitations of Mankind would be so many Theatres of Murder and Robbery. What Precautions could we take against an Enemy who would be capacitated to surprize us both by Day and Night? How should we preserve our Money, our Furniture, and Fruits, from the Avidity of a Set of Plunderers, furnished with good Arms to force open our Houses, and as good Wings to carry off their Booty, and elude our Pursuit? This Sort of Trade would be the Refuge of every indigent and impious Person.

Prior: I may add to this, that the Art we are now mentioning would entirely change the Face of Nature; we should be compelled to abandon our Cities and the Country, and to bury ourselves in subterraneous Caves, or imitate Eagles and other Birds of Prey; we should retire, like them, to inaccessible Rocks, and craggy Mountains, from whence we should from time to time, sally down upon the Fruits and Animals that accommodate our Necessities; and from the Plain we should immediately soar up to our Dens and Charnel Rooms.

Countess: Ah! Gentlemen, you make me tremble at your Art of Flying; and I bestow beforehand my Imprecations on the Person, who shall attempt to make it practicable. Let me hear no more of Dens and Charnel Rooms. Do you see, Chevalier, what you expose us to with your Inventions?

Count: Make yourself easy on this Head. We need not be under any Apprehensions about the Art of Flying, which, indeed, is an absolute Impossibility; Nature herself has formed an Obstacle against it, that is, in some Measure, made invincible by the exceeding Disproportion between the Weight of the Air and an human Body. The hollow Machine that one must imagine capable of sustaining the Body of a Man, and placing it an equal Ballance with the Air, would be so immoderately large and cumbersome, that learned Men have judged the Management and Use of it to be altogether impracticable, and as much forbidden to Man as the perpetual Motion.

This combined onslaught crushed into silence the prophetic intelligence of the young Chevalier, who, perhaps, was one of M. Santos-Dumont's forefathers, seeing that "Nature Display'd" is translated from the French. Yet it seems that the Prior-Curate would have burned the gallant Frenchman at the stake, for flying in the face of Providence; and one trembles to think of the fate that would have overtaken the apostate Bacon! In spite of the growth of aerial navigation, and the gloomy forebodings of the Count, we have not yet heard of any aeronauts summoned to the police court for purloining Fruits and Furniture from the Habitations of Mankind.

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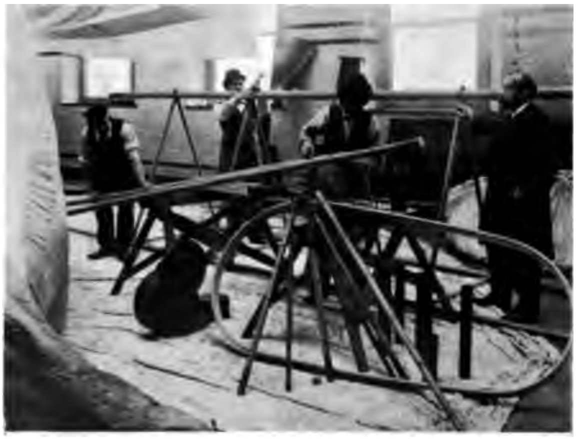
The phrase "building castles in the air" will soon have another and more materialist significance with the increase in ballooning and aerostatics.



*Campbell & Grey.*

**Building the new 1903 airship at Messrs. Spencer's. The motor by which it is propelled will develop 24 h.p.**

# Aeronautical Institute and Club of Great Britain.

A GENERAL meeting of the Aeronautical Institute and Club was held at St. Bride's Institute, Fleet Street, on Friday, February 20th, with Mr. P. L. Senecal, the vice-president, in the chair. A paper by Mr. W. J. Griffiths, entitled, "A Novel Method of Navigating the Air," was read, which gave some interesting particulars of a flying machine built on the aeroplane principle. The machine consists of superposed aeroplanes, supported by a framework, and capable of being adjusted at any required angle. The car containing the aeronaut and machinery is suspended below, and the machine is driven by six propellers.

A paper which followed, entitled "An improved Kite or Flying Machine," by Messrs. Tarczal, Poheim, and Simko, gave the description of a kite constructed of "stepped" aeroplanes. This apparatus, if furnished with suitable motive power and propellers, could be used as a flying machine, the design of the machine giving it great stability when in the air.

A long discussion followed the papers, and Mr. J. J. Carter gave some details of tests carried out by himself for the purpose of discovering the lifting power of aeroplanes and aerocurves when driven through the air at different speeds.

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A GENERAL meeting of the Aeronautical Institute and Club was also held at St. Bride's Foundation Institute, Ludgate Circus, E.C., on March 20th, Dr. F. A. Barton (president) in the chair. Viscount Maitland was elected a vice-president of the Institute. The following appointments were also made: Official consulting engineer, Mr. F. L. Rawson; official aeronaut, Mr. Auguste E. Gaudron; official patent agent, Mr. B. King. A communication was received from the South-East London Engineering Works offering members of the Institute the use of their lathes and workshops at a nominal fee in order that those not possessing the necessary facilities might work out their models in private and at the least possible cost.

Dr. Barton announced that an exhibition of aeronautical apparatus and accessories of all descriptions had been arranged by the committee. Sections will be set apart for airships (including models of those which are "heavier than air" and "lighter than air"), parachutes, flying machines, and light motors for driving airships or ships' propellers. There will also be a historical section, and probably sections for foods and clothing specially adapted for aeronauts. The exhibition will be opened on Saturday, July 18th, and will remain open for at least one month; in fact, if it proves as popular as is anticipated, it will remain open for a longer period. Medals and certificates will be awarded to exhibitors.

To cover the exhibition expenses a guarantee fund was started by the Institute, and Dr. Barton was pleased to announce that the whole amount was forthcoming in one evening. As, however, others desired to take part in the guarantee, it had been arranged for them to take shares. Notices would be issued shortly with reference to the matter by the exhibition secretary, Mr. Vernon W. Ledger, 14, Manor Road, Beckenham. It may be interesting to record that the membership fee of the Institute will cover an exhibitor for a certain space, and he will then be able to show a model without cost. If the machine or exhibit is of exceptional dimensions, an additional fee in proportion will be charged. The unpacking of exhibits will be done by the Institute free of charge, and they will also be insured against fire and breakage. In view of the fact that the society has only been in existence for a period of fifteen months, its activity and enterprise are highly commendable.

Dr. Barton's airship, designed to combine both the balloon and aeroplane systems, is in course of construction at the Alexandra Palace, where the exhibition is to be held; and in accordance with the president's contract with the War Office, the airship will be completed by the time the exhibition opens, in order that a series of trial trips can be made. The construction of the vehicle has been pushed forward vigorously, and at the present time only the balloon portion remains to be added.

# The London Chamber of Commerce.

## Interesting Speeches.

SPEAKING at the monthly dinner of the London Chamber of Commerce at the Trocadero on Wednesday evening, 18th March, Sir Vincent Kennett-Barrington said he had some little experience of airships and of Sir Hiram Maxim's aeroplane, and it was his opinion that it was due to the efforts of the automobilist that weight had been greatly reduced in the machine, rendering the navigation of the air more feasible. While on a visit to Washington recently, he had the pleasure of seeing Professor Langley, who was well known in the world of aerial navigation, and he left him with the impression that the solution of the difficulties that beset them at the present time did not lie in the steering, but in a combination of the airship and the aeroplane. They were going to be "married," he said, and it was satisfactory to know that the American Government and the British Government had evinced the most friendly regard for the development and improvement of the machine.

Mr. Chas. Jarrott, of the Automobile Club, who was present, expressed the conviction that the introduction of the petrol motor would come as a boon to the aerial navigator. He descanted eloquently upon the joys of travelling in the air. He had been in a balloon, but not in an airship. He experienced no sense of speed, but sat still in the dead silence of empty space. He heartily wished success to all aerial navigators who could pursue the pleasures of their craft in a region where the speed limit was not recognised.

Dr. F. Alex. Barton contributed some interesting remarks, and, speaking as president of the Aeronautical Institute, he was listened to with great respect. Speaking of the fabric of the balloon, he was in favour of skin, though very fine silk impregnated with oil he believed held the gas as well as anything. At the present time he was building at the Alexandra Palace an airship under contract with the War Office. It was a combination of the systems favoured by two opposing bodies of aeronauts, viz., the "lighter than air" system and the "heavier than air" system. It was a machine in which movable aeroplanes were interspersed between the car and the balloon. This airship would be 108ft. long, weigh about 5½ tons, or just over 11,000 lbs., and would be propelled by six multiple propellers, each pair being driven by an engine which, combined, would give 150 h.p. If the results obtained were satisfactory, the War Office would have another airship built by him, larger and stronger, with probably from 600 h.p. to 800 h.p. engines. The size and number of the aeroplanes would be increased, and the balloon would be strengthened; but its proportions would be diminished. By gradual progress, increasing the size of the aeroplanes and the motive power, but diminishing the diameter of the balloon, he hoped to attain a practical commercial airship. He calculated that such an airship might reach a speed of from sixty to eighty miles an hour.

Dr. Barton let his fancy roam into untold possibilities for his ideal in relation to the commercial economy of the world. It might be used, he said, for the exploration of such countries as the Hinterland of the West Coast of Africa, the interiors of Brazil and Australia, and the country stretching far away on either side of large rivers like the Amazon and the Congo—regions now almost inaccessible owing to the difficulty of crossing fever-laden swamps and dense forests. He pictured its employment in naval and military manœuvres, and in the service of the nation in war time, when the movements of the enemy might be descried from a lofty vantage point in the sky, which would otherwise be impossible; and in communicating the news to our own forces, we should become "forewarned and forearmed." He even fancied in the dim future the exhilarating spectacle of an airship regatta, which might eclipse the glories of the Gordon-Bennett race—a remark which created much merriment.

Mr. Hutchinson, who followed, said perfection in airship construction could only be achieved by experiment. For experiment, money was required, and there were plenty of people in this country who had more money than they knew what to do with. At present it was left to the sporadic efforts of the few to conduct these costly experiments, and in the interests of mankind and commerce and human progress, this should not be.

The sentiment was cordially endorsed by the members present.

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## THE AERO CLUB.

### Some 1903 Fixtures.

That the Aero Club intend to be very active during the coming season is evident from the following preliminary programme which it has just issued:

Apr. 25—Saturday...Aero Club Meeting, No. 5. at the Crystal Palace.
May 9—Saturday...Aero Club Meeting, No. 6. at the Crystal Palace.
„ 23—Saturday...Aero Club Meeting, No. 7, at the Ranelagh Club.
„ 28—Thursday...Aero Club Meeting, No. 8, at the Crystal Palace.
June 6—Saturday...Aero Club Meeting, No. 9. at the Ranelagh Club Evening Meeting and Night Ascent (about 9.30.)
„ 10—Wednes. ...Aero Club Meeting, No. 10, at the Ranelagh Club. (Special Meeting).
„ 25 Thursday...Aero Club Meeting, No. 11, at the Crystal Palace.
July 4—Saturday ...Aero Club Meeting, No. 12, at the Crystal Palace.
„ 16—Thursday...Aero Club Meeting, No. 13, at the Crystal Palace.
„ 25 Saturday ...Aero Club Meeting, No. 14, at the Crystal Palace.
Nov. 25 Wednes. ...Anniversary Dinner at the Carlton Hotel, London.

The ascents from the Crystal Palace will take place at 2.30 p.m. from the Balloon Ground, and from the Ranelagh Club, as will be announced. Cards of membership will be issued to members, which will admit them inside the balloon enclosure at the Crystal Palace. At least two balloons will ascend at each meeting. Arrangements are being made for motor cars to pursue the balloons at some of the meetings, and prizes will be offered for a capture to members of the Aero Club and the Autombile Club. Further fixtures will be announced.

# Kite Flying and the Weather.

AT the recent annual meeting of the Royal Meteorological Society, the President, Mr. W. H. Dines, delivered an address on "The Method of Kite-flying from a Steam Vessel, and Meteorological Observations obtained thereby off the West Coast of Scotland." The idea of using kites to obtain meteorological observations was said to be one of long standing, having been put forward so long ago as 1749 by Dr. Alex. Watson, of Glasgow. In 1883 Mr. Archibald used kites to discover the change of wind velocity with elevation; but the credit of inaugurating the method so extensively used during recent years was due to Mr. Rotch, who had been most successful at kite-flying in America, and who had also pointed out the advantage that could be gained by using a steam vessel for observations at sea. Committees had been appointed by the Royal Meteorological Society and the British Association, with the result that almost daily observations were made during the months of June, July, and August last year, at first from a land station and afterwards from the deck of a small steam tug, at Crinan, on the West coast of Scotland. For observations to the height of 4,000 or 5,000 feet, the apparatus required was not costly; but for higher elevations a more extensive outfit was necessary. A detailed description of the apparatus which had been perfected by himself was given by the president, as well as his method of making the observations. A steam engine was found preferable for the winding of the several miles of wire necessary for an ordinarily high observation. It was found practicable to procure eight miles of wire in one piece. A good kite was the most important of all the apparatus, and that recommended was a modified form of the Hargreave kite. In addition to the apparatus, at least three skilled persons were required to assist in the observation, except under the most favourable circumstances. Self-recording instruments were sent up on every occasion when the wind was strong enough; they were hung from the wire, about 200ft. below the kite, and consisted of a self-recording aneroid barometer to give the height, a thermograph, and a self-recording air hygrometer. These instruments weighed three pounds, and with very light winds could not be sent up. Observations were made to the height of 15,000ft., and this entailed the use of four kites. At Crinan, with a wind anywhere from the west, the observations might be taken as equivalent to ascents over the Atlantic Ocean. A great uniformity of temperature was found to prevail from hour to hour over the sea, and Mr. Dines gave it as his belief that the daily range of temperature over the ocean is less than 0.5°. Less change of wind direction was found over the sea than over the land. On several occasions it was discovered that the wind was blowing with a velocity of from thirty to forty miles per hour at a height of 1,000ft., when it was almost calm at the surface, and it was generally found that the wind increased slightly with increasing elevation. No sign of any electrical manifestation was ever observed; but means were taken to obviate any interfering cause by electricity.

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A French firm are building 100 h.p. motors for balloons, one of six cylinders and the other of four cylinders, the latter for M. Jacques Lebaudy.

# Short Flights.

A very enthusiastic lady aeronaut is Miss Vera Butler, the daughter of Mr. F. Butler, the well-known balloonist and autocarist. This lady had an interesting article in *The Car* recently dealing with "Some Impressions of Ballooning."

* * *

Japan, keeping pace as usual with the most advanced modern methods, has decided on a balloon service for its army, and has entrusted its organisation and direction to an officer who has made ballooning a speciality. This officer, Captain Tokunaga, is now travelling abroad, studying all forms of aerial navigation in Europe and America, and the Japanese Government, it is said, will give him every opportunity to further his researches and experiments. The Department of Strategy of the Japenese army is especially interested in this matter, and will have constructed shortly an experimental building where the balloons and apparatus can be tested, with the view of adopting, or, perhaps, inventing, some form of airship for the manœuvres of the Imperial army.

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An Italian engineer has invented a new steerable balloon which he calls an "aerial waggon." It is rectangular in form, is fitted with an 8 h.p. motor, and has three screws, two for ascending purposes and one for driving the balloon through the air.

* * *

In the course of an address at Brighton the hon. secretary of the Aeronautical Society of Great Britain announced that, with a view to solving, if possible, some of the difficult problems connected with air currents above 3,000 feet, arrangements were in progress for holding, at an early date, a great international kite-flying competition. The experiments, which would probably take place near Brighton, were likely to prove the most important of the kind in the history of aerial navigation.

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